Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

APRIL, 1957

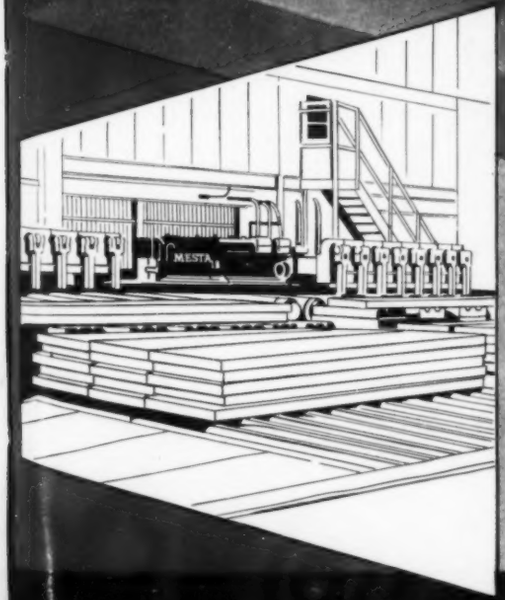
TECHNOLOGY DEPT.

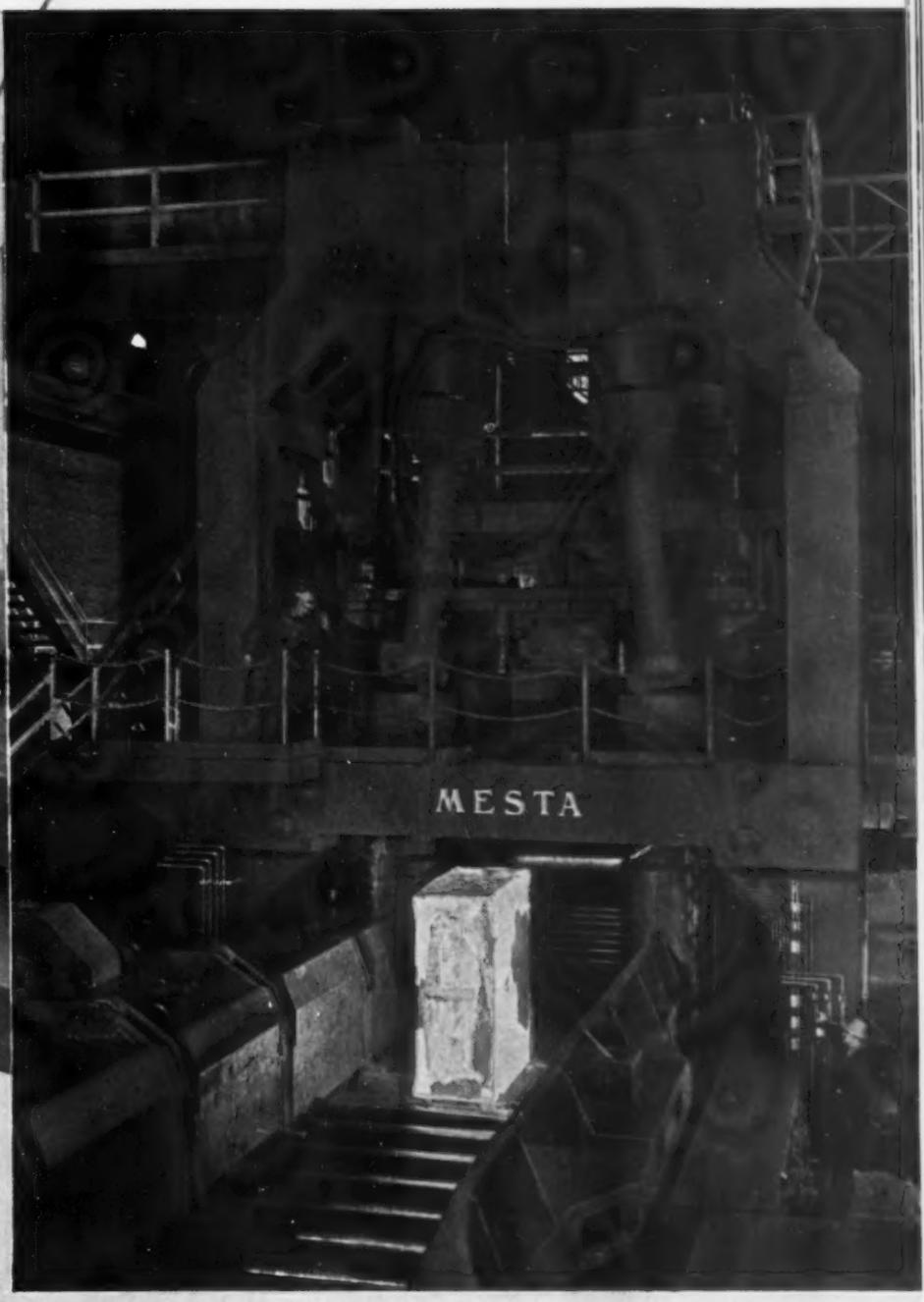
TABLE OF CONTENTS, PAGE 3

PUBLIC LIBRARY
APR 29 1957
DETROIT

SLABBING MILLS

Designed and Built by MESTA





Rolling 20 Ton Ingots into Slabs on a Mesta 45" x 90" Universal Reversing Slabbing Mill

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

MESTA
THERE IS NONE BETTER

This welded magnet can really make sense to you

The *coil* is welded into a capsule, removable and replaceable in the field

The outer pole shoe is welded to the body

And it all adds up to more copper, more lift, more life, more "no-trouble" periods.

Now available to you in a *better* welded design is the Cutler-Hammer Supermagnet . . . the magnet that has been "super" since it started. We say this is better because here welding makes sense. Welding is used to seal the coil into a compact, homogeneous, monolithic mass that is moisture proof and can be removed from the body on the job for repairs without trouble.

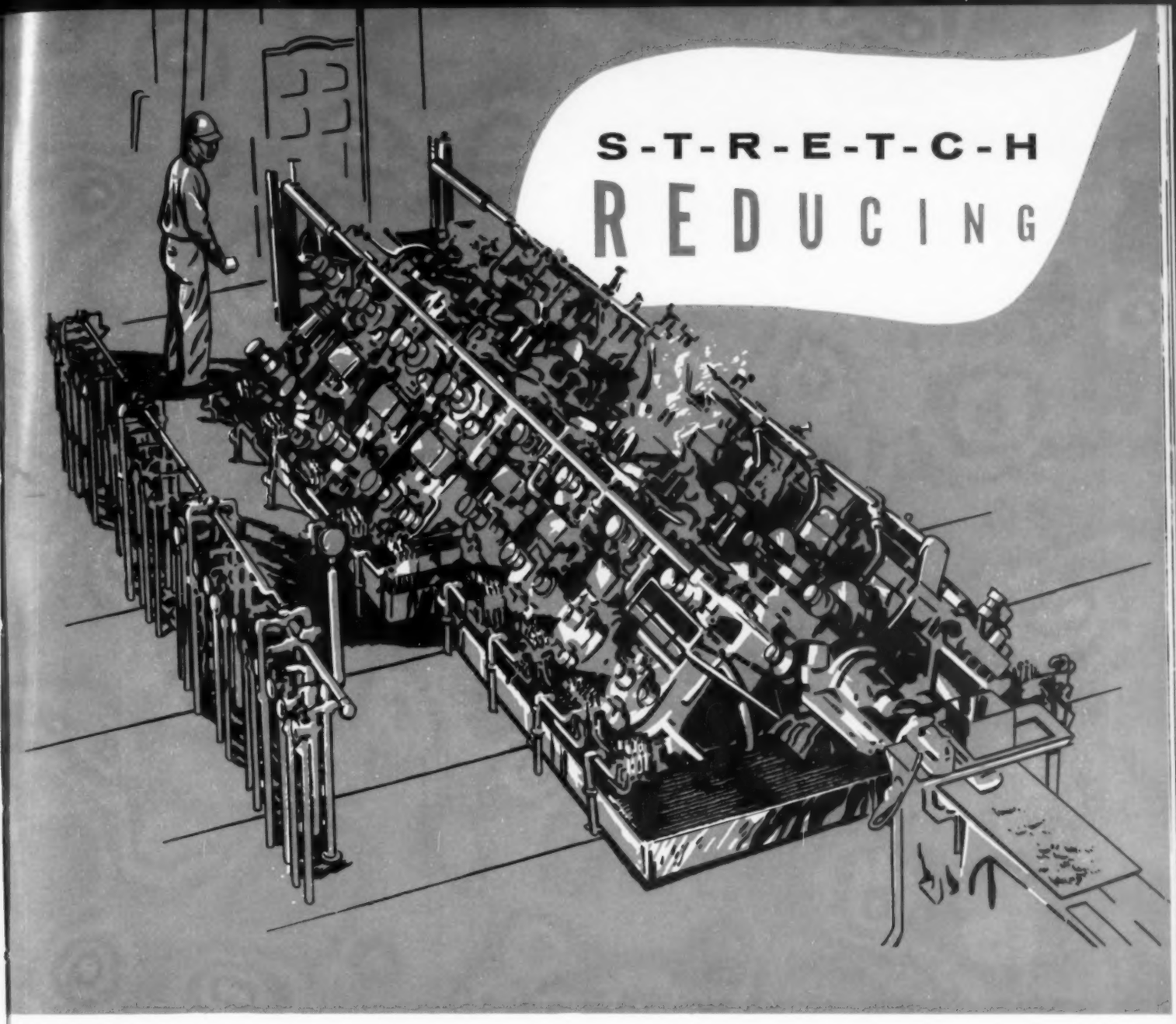
Welding is used to unite the cast dynamo steel body and the alloy steel outer pole shoe into a rugged, wear-resistant unit. On the other hand, this unit retains the uniformity of magnetic flux density between the inner and outer pole shoes that means more lifting power, a bigger "bite."

The coil shield has an improved and heavier cross section to better protect the coil. The inner pole shoe—which of all magnet parts gets most wear—is *NOT* welded but held in place by countersunk through bolts, so it can be easily removed and replaced.

You'll find other advantages too—the design of the lugs, the design of the cast steel chain yoke, the design of the terminal box: these are some of the features that make the "Supermagnet" super. Ask for new magnet book THE BIG LIFT. Shows the complete C-H line welded, bolted and special magnets. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin.

CUTLER-HAMMER
SUPERMAGNETS
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Entered as second class matter at Easton, Pa., with additional entry at Pittsburgh, Pa.



● Much of the news in Seamless concerns the Stretch Reducing principle. The first such mill was installed by National Tube Division of U. S. Steel Corporation. Aetna-Standard collaborated with National Tube in designing this mill and supplying the equipment. Since that time, much development work has been done on the equipment and the process.

Chief advantage of the Stretch Reducing method is the resulting increase in tonnage from existing Seamless Tube Hot Mill equipment for the production of A. P. I. steel tubing. Briefly, tubes of the larger O. D. (6″ to 7″) are produced through the existing Piercer, Plug Mill and Reelers, thereby obtaining a maximum number of tubes at an increased tonnage per operating hour.

Aetna-Standard has built and is building most of the Stretch Reducing mills. If your group needs facts on cost, design, yield and other information, Aetna's Seamless engineers can help you.

AETNA • STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

GENERAL OFFICES: PITTSBURGH, PA. **PLANTS: ELLWOOD CITY, PA., WARREN, OHIO**

CONTINUOUS GALVANIZING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

NATIONAL BRUSHES
TRADE-MARK

are preferred for **TURBINE-GENERATOR COLLECTOR RING SERVICE**

GRADE 634

Designed for high speed excitation collector ring service.

The increased capacity of today's modern turbine-generator is directly related to increased excitation of the rotor. Here, where high-speed steel collector rings operate at peripheral speeds up to 15,000 fpm, "National" brushes Grade 634 provide low inertia as well as low wear rate on both brushes and rings. No wonder these service-proven brushes are universally preferred by turbine-generator manufacturers everywhere. If you are faced with a brush performance or commutation problem, feel free to call on NATIONAL CARBON for specialized advice.

UNION CARBIDE

The terms "National", "Union Carbide" and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY • **A Division of Union Carbide and Carbon Corporation** • ***30 East 42nd Street, New York 17, N. Y.***
SALES OFFICES: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco • **IN CANADA**: Union Carbide Canada Limited, Toronto

T. J. ESS, *Editor*
I. E. MADSEN, *Associate Editor*
W. C. FRIESEL, *Advertising Manager*
T. A. KOCIS, *Production Manager*

Board of Directors

PRESIDENT
J. D. O'ROARK
Assistant Manager
Department of Service and Maintenance, Electric, Weirton Steel Co.

FIRST VICE PRESIDENT, LEONARD LARSON, *Chief Engineer,* Cleveland Works, Republic Steel Corp.

SECOND VICE PRESIDENT, EMIL KERN, *Vice President of Engineering,* Allegheny Ludlum Steel Corp.

TREASURER, S. C. READ, *Director of Construction and Maintenance,* Jones & Laughlin Steel Corp.

SECRETARY, C. E. PRITCHARD, *Superintendent, of Mills,* Alan Wood Steel Co.

PAST PRESIDENTS: JOHN H. VOHR, *General Superintendent,* United States Steel Corp., Gary Steel Works.

W. H. COLLISON, *Plant Superintendent,* Blast Furnaces and Coke Works, Great Lakes Steel Corp.

HONORARY DIRECTOR: JAMES FARRINGTON, Steubenville, Ohio.

DIRECTOR-AT-LARGE: H. L. JENTER, *Vice President of Operations,* United States Steel Corp., American Steel & Wire Div.

DIRECTORS: E. L. TINDALL, *Assistant Vice President,* Engineering, United States Steel Corp.

F. A. GARMAN, *Chief Engineer,* United States Steel Corp., American Steel & Wire Div.

E. F. DONATIC, *General Superintendent,* Kaiser Steel Corp.

G. W. TESKEY, JR., *Superintendent,* Open Hearth Dept., Bethlehem Pacific Coast Steel Corp.

W. C. SCHULZ, *Superintendent,* Mechanical Dept., Steelton Plant, Bethlehem Steel Co.

A. G. HENRY, *Superintendent of Maintenance,* United States Steel Corp., Tennessee Coal & Iron Div.

R. T. WINTERRINGER, *Assistant Superintendent,* Electrical Dept., South Chicago Works, Republic Steel Corp.

K. E. LEWIS, *Supervisor,* Quality & Processing, Rotary Electric Steel Co.

D. C. McCRADY, *Superintendent* Electrical Dept., Steel Company of Canada, Ltd.

G. R. CLARKE, *General Superintendent,* Laclede Steel Co.

J. H. STONE, *Assistant Superintendent,* Cold Strip Mill, Youngstown Sheet & Tube Co.

R. G. NOLAN, *Electrical Engineer,* Granite City Steel Co.

G. H. KRAPF, *Division Superintendent,* Power Production, United States Steel Corp., South Works.

G. H. GREENE, *Assistant General Manager,* Johnstown Works, Bethlehem Steel Co.

C. S. LAMBERT, *Superintendent,* Merchant Mills, Youngstown Sheet & Tube Co.

C. W. BRUCE, *Chief Engineer,* Chicago District, Republic Steel Corp.

D. E. WHITEHEAD, *Materials & Standards Engineer,* Crucible Steel Company of America.

Managing Director
T. J. ESS
Empire Building
Pittsburgh, Pa.

Iron and Steel Engineer

APRIL, 1957 VOLUME XXXIV NUMBER IV

In This Issue

Crops and Shorts 11
Patent Reviews—By Melvin Nord, Patent Attorney, Detroit, Mich. 27
The New 10-In. Bar Mill—Jones & Laughlin Steel Corp.—By H. I. Smith, Assistant Superintendent, Rolling Mills, Jones & Laughlin Steel Corp., Pittsburgh, Pa. 75
Continuous Annealing Lines for Tinplate—Recent Trends and Problems—By J. H. Hopper, Manager Application Engineering, User Industrial Sales Dept., East Central District, General Electric Co., Cleveland, Ohio, and A. Jakimovich, Steel Mill Systems Engineering Section, General Electric Co., Schenectady, N. Y. 80
The Application of Sintered Oxide Cutting Tools—By Louis M. DeMarco, Stupakoff Division, The Carborundum Co., Latrobe, Pa. 87
Design and Operation of a Blast Furnace with a Carbon Bosh Lining—By E. K. Miller, Jr., Assistant Division Superintendent, Blast Furnaces, Gary Steel Works, United States Steel Corp., Gary, Ind. 91
Methods for Reclaiming and Processing Scrap from Steel Plant Slags and Refuse—By Lawrence J. Fritz, Assistant to General Superintendent, Heckett Engineering, Inc., Butler, Pa. 95
Mill Requirements Point to Five-Zone Furnace—By J. E. Hovis, Manager, Industrial Furnace Division, The Gas Machinery Co., Cleveland, Ohio 98
Reducing Smudge on Cold Rolled Sheet—By Michael A. Matz, Special Technical Assistant, Continuous Sheet & Strip Dept., Jones & Laughlin Steel Corp., Pittsburgh, Pa. 105
Detroit at Portsmouth—By T. J. Ess ..... following page 106
Evaluation and Specification of Paint for Industrial Use—By Joseph Bigos, Senior Fellow, Mellon Institute and Director of Research, Steel Structures Painting Council, Pittsburgh, Pa. 107
Pictorial Roundup—AISE Western Meeting 122
Nuclear Technology and the Steel Industry—By Dr. R. P. Petersen, Director Nuclear Research, Republic Steel Corp., Cleveland, Ohio 124
Program—AISE Spring Conference 129
Abstracts of Technical Papers, AISE Spring Conference 131
Current AISE District Section Meeting Notices 138
Metallurgical Analysis as a Tool for Maintenance and Operating Departments— 139
Organization of Steel Plant Maintenance Metallurgical Dept.—By R. H. Davis, Maintenance Metallurgist, Gary Steel Works, United States Steel Corp., Gary, Ind. 139
Analysis of Failures for Steel Mill Maintenance—By J. V. Russell, Chief Metallurgist, Republic Steel Corp., Chicago, Ill. 142
Metallurgical Analysis—A Tool—By M. E. Olson, Superintendent, Mechanical Maintenance, Youngstown Sheet & Tube Co., East Chicago, Ind. 146
Date-line Diary 157
Industry News 167
Personnel News 187
Equipment News 213
Book Reviews 225
Publication Service 205
Applications for AISE Membership 238
Index to Advertisers 241

Published Monthly by

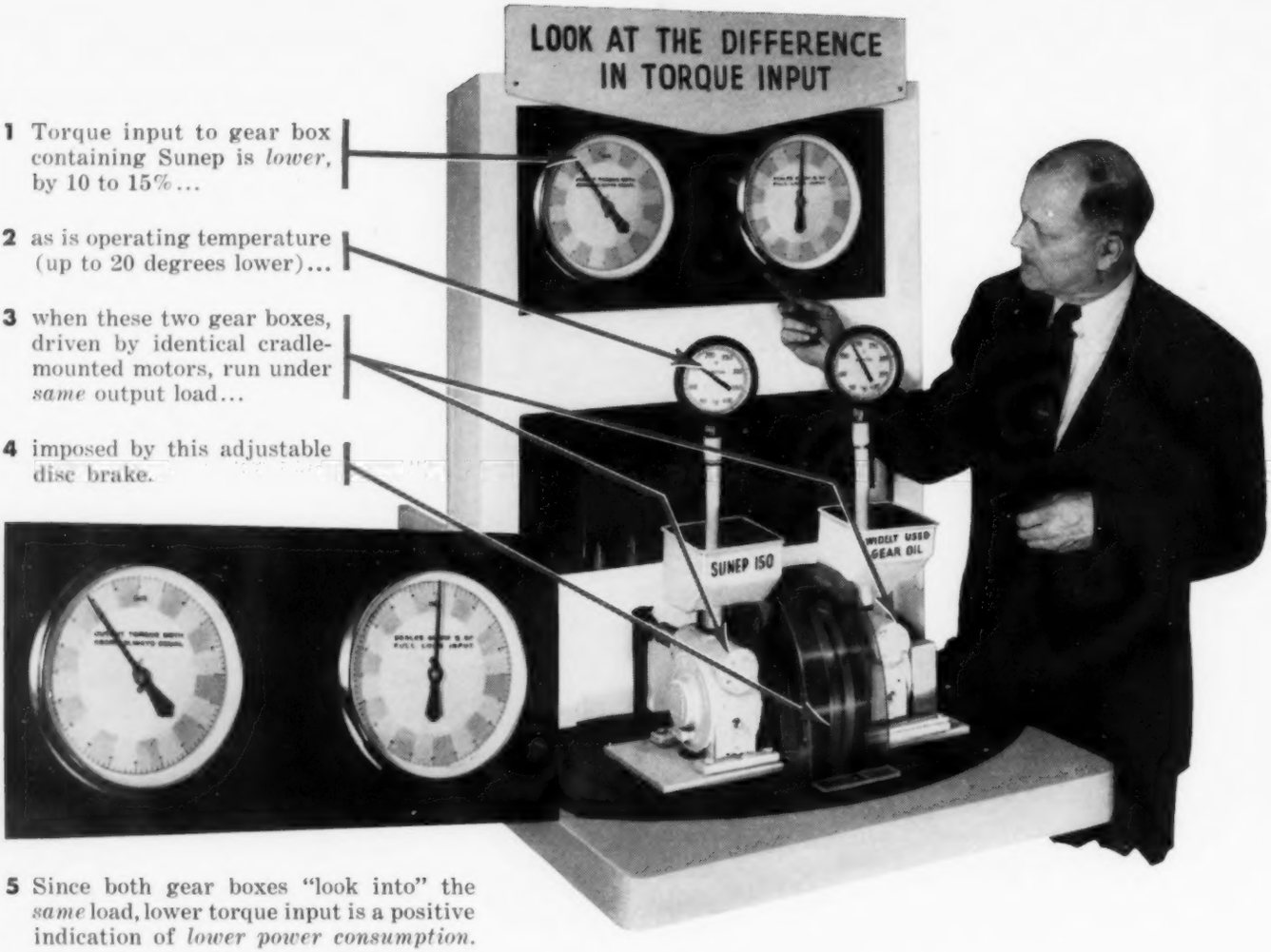
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

Copyright, 1957, The Association of Iron and Steel Engineers.

Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds) ..... $ 7.50 per year
Subscription price in foreign countries (U. S. funds) ..... $10.00 per year


LOOK AT THE DIFFERENCE IN TORQUE INPUT
1 Torque input to gear box containing Sunep is *lower*, by 10 to 15%...
2 as is operating temperature (up to 20 degrees lower)...
3 when these two gear boxes, driven by identical cradle-mounted motors, run under *same* output load...
4 imposed by this adjustable disc brake.
SUNEP 150
WIDELY USED GEAR OIL
5 Since both gear boxes "look into" the *same* load, lower torque input is a positive indication of *lower power consumption.*

This test rig proves...

SUNEP CUTS POWER CONSUMPTION, REDUCES OPERATING TEMPERATURES

TIME AND AGAIN, under equal operating conditions, Sunep® gear lubricant has demonstrated its superiority over competitive oils. Sunep is a high-quality, extreme-pressure lubricant that is also recommended for screws and heavily loaded bearings.

In addition to extreme-pressure characteristics, Sunep has the ability to combat rust and corrosion. All additives are compatible and do not drop out during use or prolonged storage. These advantages add up to savings in money and equipment for you.

For complete information about Sunep oils, call your Sun representative or write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. IS-4.

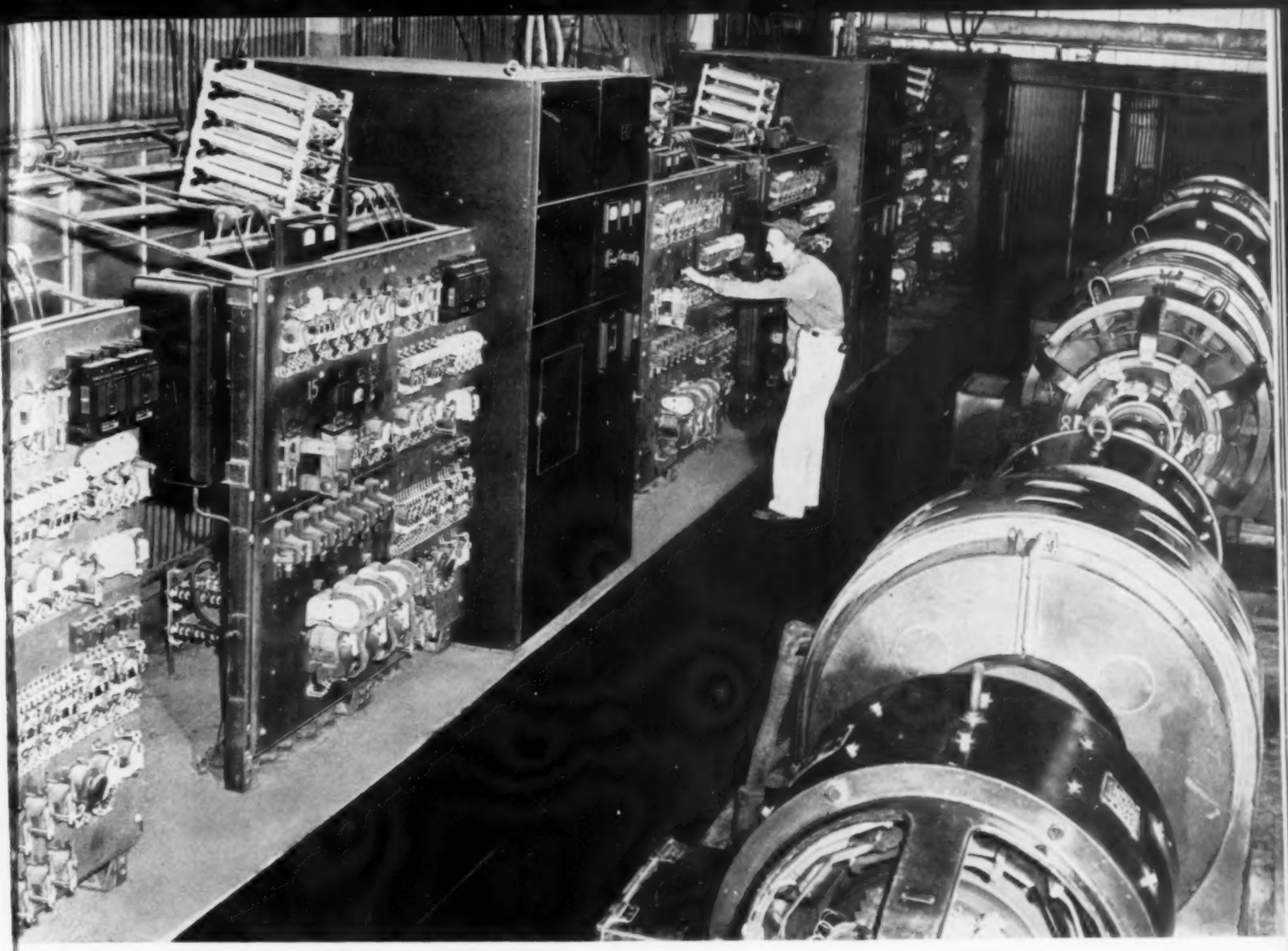
INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY Philadelphia 3, Pa.

IN CANADA: SUN OIL COMPANY LIMITED, TORONTO AND MONTREAL

SUNOCO®

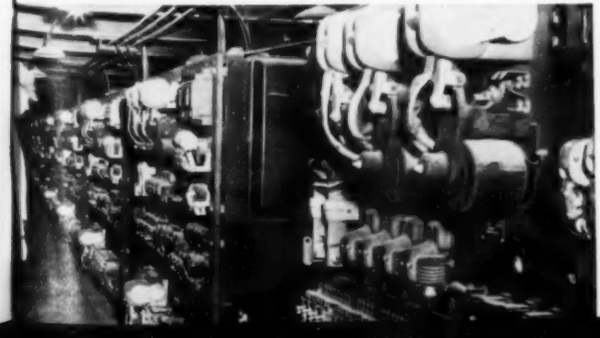
©Sun Oil Company



CLARK provides dependable, low-maintenance control for 16 wire blocs at Portsmouth Div., Detroit Steel Corp.

Above—Battery of Vaughn "HRM MOTOBLOX".

Below—Clark control panels for the 10 Constant Potential wire blocs at Portsmouth Division, Detroit Steel Corp.



A battery of 16 Vaughn wire-drawing machines at the Portsmouth Division of Detroit Steel Corporation includes 6 Variable Voltage "HRM MOTOBLOX" for drawing high carbon wire primarily, and 10 Constant Potential "HRM MOTOBLOX" for low carbon wire. The Variable Voltage machines were designed for speeds up to 2500 FPM, the Constant Potential for 1700. All are CLARK controlled.

Installed in 1948, they represented the first Vaughn HRM wire blocs in service and were the fastest available at that time. After more than 8 years of continuous operation, mill officials report that all CLARK control has performed very satisfactorily and that for the tonnage of wire produced, electrical maintenance has been extremely low.

Illustration above shows several of the Clark control panels for the Variable Voltage wire blocs. In addition to wire-drawing, Clark equipment controls many other production operations in this huge Portsmouth, Ohio steel mill.

The CLARK CONTROLLER *Company*

Everything Under Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

JOY Electrical Connectors

Make the Difference

Photos Courtesy of
GREAT LAKES STEEL CORPORATION
(Division of National Steel Corporation)
ECORSE, DETROIT 29, MICHIGAN.

. . . they're "FACTORY MOLDED" as one-piece Neoprene/rubber units!

Can you think of a more demanding environment for electrical connectors . . . than the water-soaked, run-out motor installation pictured above? If you can, odds favor a bet that JOY connectors are "at work" there, too! For in all those qualities that add up to a long life of dependable, maintenance-free performance, JOY electrical connectors excel.

Factory molded as one-piece Neoprene jacketed units, *that resist impact damage like a rubber ball, and are practically immune to the aging effects of oils, acids, alkalines and sunlight . . .* JOY electrical connectors are rapidly becoming Industry's favorites for portable power and control circuits. When connected, close-fitting face sections provide "cork-like" seals around engaged contacts, protecting them from moisture, metallic dust and other airborne particles that are so damaging to an electrical connector's performance.

Want specific information on JOY connectors for your electrical circuits? Describe your needs and we'll mail it promptly! You'll be glad to have this information handy, next time you need good electrical connectors.

Use them with . . .

- RUN-OUT TABLE MOTORS
- ELECTRO-MAGNET FEEDERS
- WELDING WHIPS & CABLE
- MAN-COOLING FANS
- MOTOR CONTROL CIRCUITS
- COILING MOTOR FEEDERS
- TRANSFER CAR FEEDERS
- CONVEYOR CIRCUITS
- SAND-SLINGER CABLE
- POWER LINES TO LADLES

YOURS . . . ASK FOR IT!

BULLETIN B41 — An attractive, three-color bulletin that illustrates and describes JOY electrical connectors for Steel Mills, Foundries, and other heavy industrial needs.

CD 1156.1

JOY MANUFACTURING COMPANY

ELECTRICAL PRODUCTS DIVISION

1201 MACKLIND AVE., ST. LOUIS 10, MO.

EXECUTIVE OFFICES, HENRY W. OLIVER BLDG., PITTSBURGH 22, PA.

A coating in COLORS that really sticks to new Galvanized, Aluminum and Terne Plate

RUST-OLEUM®
GALVINOLEUM® COATINGS

Remember? If you didn't go over every square inch of new galvanized metal with a chemical solution before painting . . . chances are that the paint "peeled off" leaving you with a costly eye-sore!

The development of Galvinoleum Coatings by Rust-Oleum changes all this! *Now* . . . you simply brush Galvinoleum right over brand new or unpainted Galvanized, Aluminum, or Terne Plate . . . no etching . . . no weathering . . . and it *lasts and lasts!* No "peeling" worries, no costly "headaches". . . you have your choice of Red, Gray, Green, and Metallic! And you can use Rust-Oleum 575 Outside White, or any high-quality oil base house paint, over the Galvinoleum to match trim.

Pioneered, developed and field-tested by the Rust-Oleum Corporation — you have the assurance of a *brand name* backed by over thirty-five years of proved performance throughout industry. Try Galvinoleum . . . write for your illustrated Galvinoleum booklet with color charts.

RUST-OLEUM®
STOPS RUST!®

Rust-Oleum, Galvinoleum, and Stops Rust are brand names and registered trademarks of the Rust-Oleum Corporation.

Prompt delivery from Industrial Distributor Stocks.

Rust-Oleum is distinctive as your own fingerprint. Accept no substitute.

ATTACH COUPON TO YOUR LETTERHEAD—MAIL TODAY!

Rust-Oleum Corporation
2445 Oakton Street • Evanston, Illinois

☐ Complete Rust-Oleum Galvinoleum Literature With Color Charts.

☐ Free Test Sample:
☐ Red ☐ Gray ☐ Green ☐ Metallic

☐ Nearest Source of Supply.

By building this blast furnace off-site...

GRANITE CITY STEEL COMPANY'S new blast furnace. It has a hearth diameter of 25 feet (expandable to 26 feet, 6 inches) and a capacity of approximately 1,200 net tons of iron a day, twice that of the furnace it replaces.

Koppers cuts downtime for Granite City Steel

When Granite City Steel Company, Granite City, Illinois, decided to replace Blast Furnace "A" with a much larger furnace, there was *more than the usual concern* over downtime. Only the adjacent furnace was available to supply hot metal for the company's seven open hearths during this period of shutdown.

PHOTO SHOWS FURNACE BEING MOVED. Shell and superstructure of new blast furnace weigh 635 tons – are as high as a 15-story office building. Furnace was built off-site, then moved 84 feet. It was lowered into final position by eighteen 100-ton jacks.

To keep loss of pig-iron production to a minimum, the Freyn Department of Koppers Engineering and Construction Division used the off-site method of construction—a method rarely used in the history of American steelmaking.

While old furnace "A" was still producing iron, the shell of the new furnace was built some distance away. The old furnace was then blown out and dismantled; the foundation was rebuilt and the hearth and columns for the new furnace were constructed in place. Then, the new shell and superstructure, weighing 635 tons, were moved 84 feet and lowered onto the columns.

According to officials of Granite City Steel, this off-site method of construction saved between 30 and 40 days' downtime.

During the brief shutdown period while work on the stack was in progress, an additional 1,650 tons of steel were erected in the form of three stoves, a dustcatcher, gas washer, precipitator, and interconnecting mains. The skip pit was extensively revised to accommodate larger skip tubs. A new hoist house and complete charging facilities were also part of this well-timed job.

The new Koppers furnace is an important step in reaching Granite City's goal of over 30 per cent increase in annual ingot capacity.

Designing and constructing blast furnaces is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, you can count on Koppers. You are invited to consult with our Engineers and Management.

FREYN DEPT., KOPPERS COMPANY, INC.
PITTSBURGH 19, PENNSYLVANIA

KOPPERS

KOPPERS

ENGINEERING AND CONSTRUCTION

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

THE fourth western meeting of AISE, held at San Francisco, March 4, 5 and 6, was attended by 479 men from the iron and steel and allied industries, including 95 from east of the Mississippi River. Quite a few wives accompanied their men.

A good technical program and an inspection trip to the South San Francisco plant of Bethlehem Pacific Coast Steel Corporation filled the three days. Fine co-operation and service on the part of the St. Francis Hotel helped to make the meeting a success.

With a persistent California "heavy fog" prevailing most of the time, we can't say much about the weather, but perhaps we should apologize—we really didn't mean to shake up the city so badly.

▲

YOUR editor returned from California by way of the Second National Congress held by the National Chamber of the Iron and Steel Industry of Mexico. Held at Veracruz, Ver., March 17–21, this meeting was attended by about 400 men from the metallurgical and allied industries of Mexico.

The program consisted of four general assemblies and seven periods of simultaneous committee meetings dealing with almost every phase of the iron and steel industry. Several papers by men from the United States were included. Meetings were held in the Spanish Mercantile Club.

An inspection trip to Fundidora Veracruzana, S. A., disclosed two hot blast cupolas (recently rebuilt with carbon hearths) providing hot metal for one 40-ton open hearth furnace. A mixer provides storage for hot metal. A side-blown converter is being installed and plans call for another converter and, eventually, a rolling mill. At present, the plant is bottom-pouring 4 to 4½ in. square ingots for use in rolling mills owned by the same interests in Mexico City. Practically all of the equipment in the Veracruz plant was designed and built in Mexico.

The program also included a trip to Tubos de Acero de Mexico, S. A. (Tamsa). This is a modern seamless tube mill using the Calmes process, with press piercing, modified Mannesman elongation, rotary forging in Pilger mills and conventional sizing. Complete equipment for finishing and testing is provided. This plant produces API-approved pipe and was built to produce 45,000 tons a year. It is now being enlarged. Most of the equipment came from Italy and Germany. The steel used in producing pipe comes from various European countries.

The congress began and ended with a banquet and also included three of these six-course, two-and-a-half-hour luncheons, to say nothing of two or three lush buffets.

It was an interesting meeting and we were glad to be able to attend. Our special thanks go to senores Florentino Moral, Gabino Alvarez and Leopoldo Baeza y Acevez for their many kindnesses and courtesies.

▲

ACCORDING to the Houghton Line, a secretary should look like a girl, think like a man, act like a lady and work like a dog.

▲

WHILE many steel plants are still operating at or above capacity and report no plans to curtail, several plants have shut down a few open hearth furnaces, principally because of slackened demand for cold-rolled sheets.

Steel business is still good, however, with the month of February showing a new record daily production of 356,679 tons of ingots.

▲

PERHAPS the best comment about the new automobiles appeared (of all places) in the Detroit Free Press: "Every new car today looks like two sharks getting ready to mate."

▲

UNITED States industrial consumption of primary tin in 1956 is estimated at about 60,000 gross tons, approximately the same as in 1955. Imports of tin metal to the United States in 1956 totaled 62,558 gross tons.

U. S. mill shipments of tin plate in 1956 were 5,565,144 net tons.

▲

GREAT Britain will produce more electricity from atom-fueled generating plants than any other country by 1960, according to the Raytheon Mfg. Co. The U. S. A., however, will dominate in the field of nuclear reactors for research, testing and experimentation.

▲

ONE of our more cynical readers observes that an old fashioned girl nowadays is one who prefers them to martinis.

▲

SINCE 1945, the cost of living, according to the BLS consumer price index, has risen about 56 per cent. In the same period, the average hourly wage of steel workers has gone up 120 per cent.

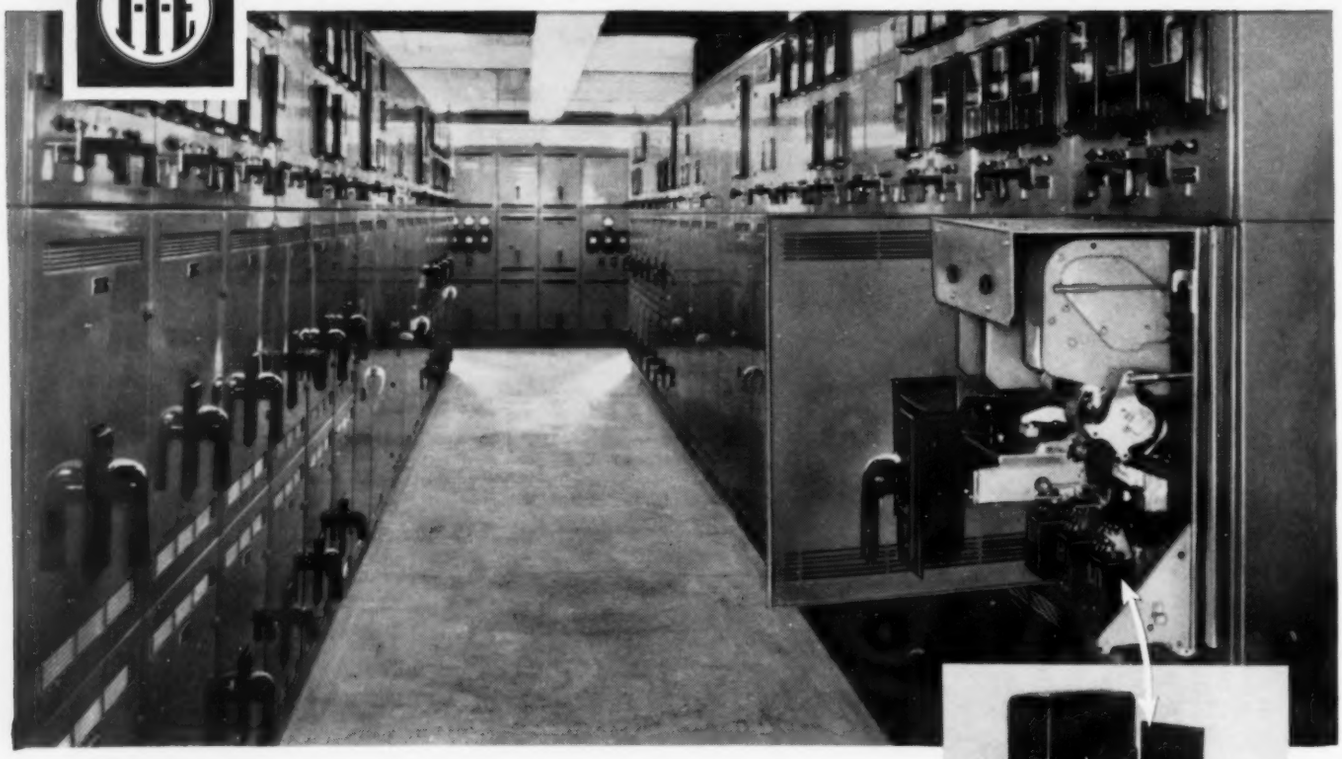
▲

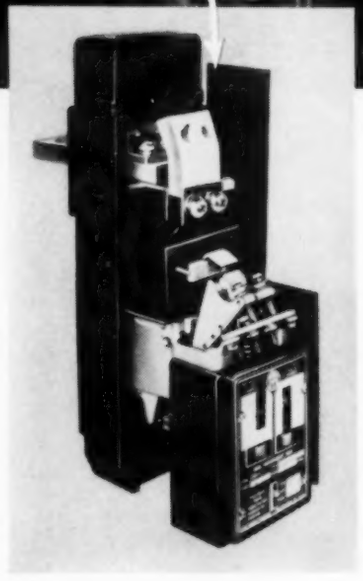
LIFE insurance totaling $54,607,000,000 was purchased in the United States in 1956. This is an all-time record, 13 per cent above the previous year.

▲

A CORPULENT friend of investigative turn of mind says it's not the minutes you put in at the table that makes you fat—it's the seconds.

LOW VOLTAGE SWITCHGEAR





Here's SENSITIVE Circuit Protection

Some temporary overcurrents are tolerable; should even be permitted to occur. But sensitive circuit protection is needed to interrupt them when they persist too long or are of too high a magnitude.

The I-T-E Type OD-1 dual magnetic overcurrent trip device gives such protection. It permits temporary overcurrents, but limits them in duration and magnitude. This device will trip the circuit breaker after a predetermined interval on relatively low overcurrents or will trip instantaneously on high-magnitude fault currents. In either case you get safe, positive protection—sensitive to the needs of the circuit and the equipment on it.

For complete information on sensitive circuit protection, including selective tripping, undervoltage and other tripping devices, contact your local I-T-E sales representative. Or write for Bulletin 6004B. I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.

Features of the I-T-E Type OD-1 Trip Device

PRECISION BUILT and factory calibrated to provide the highest possible accuracy in operation.

SEALED SILICONE TIMING ELEMENT. No maintenance. No oil to handle, no level to maintain, no sludging.

QUIET. Resonant vibration dampeners prevent a-c noise and wear on parts.

COMPLETELY ADJUSTABLE IN SERVICE. The delay pickup is easily adjusted from 80 to 160% of the continuous current rating. The instantaneous pickup is adjustable from 500 to 1500% of the continuous current rating. The time delay is adjustable to any of three time delay bands—minimum, intermediate and maximum.

SAFE DEAD FRONT DESIGN. Insulated knobs permit safe adjustment on a *hot* circuit breaker.

DEPENDABLE impact tripping action. The *hammer blow* movement of the time delay armature at end of timing stroke gives positive operation.

FAST RESETTING. Sensitive check valve on the piston provides quick resetting of the time delay. Repeat tripping is assured.

I-T-E CIRCUIT BREAKER COMPANY • Switchgear Division

IN CANADA: EASTERN POWER DEVICES, LTD.

WITH

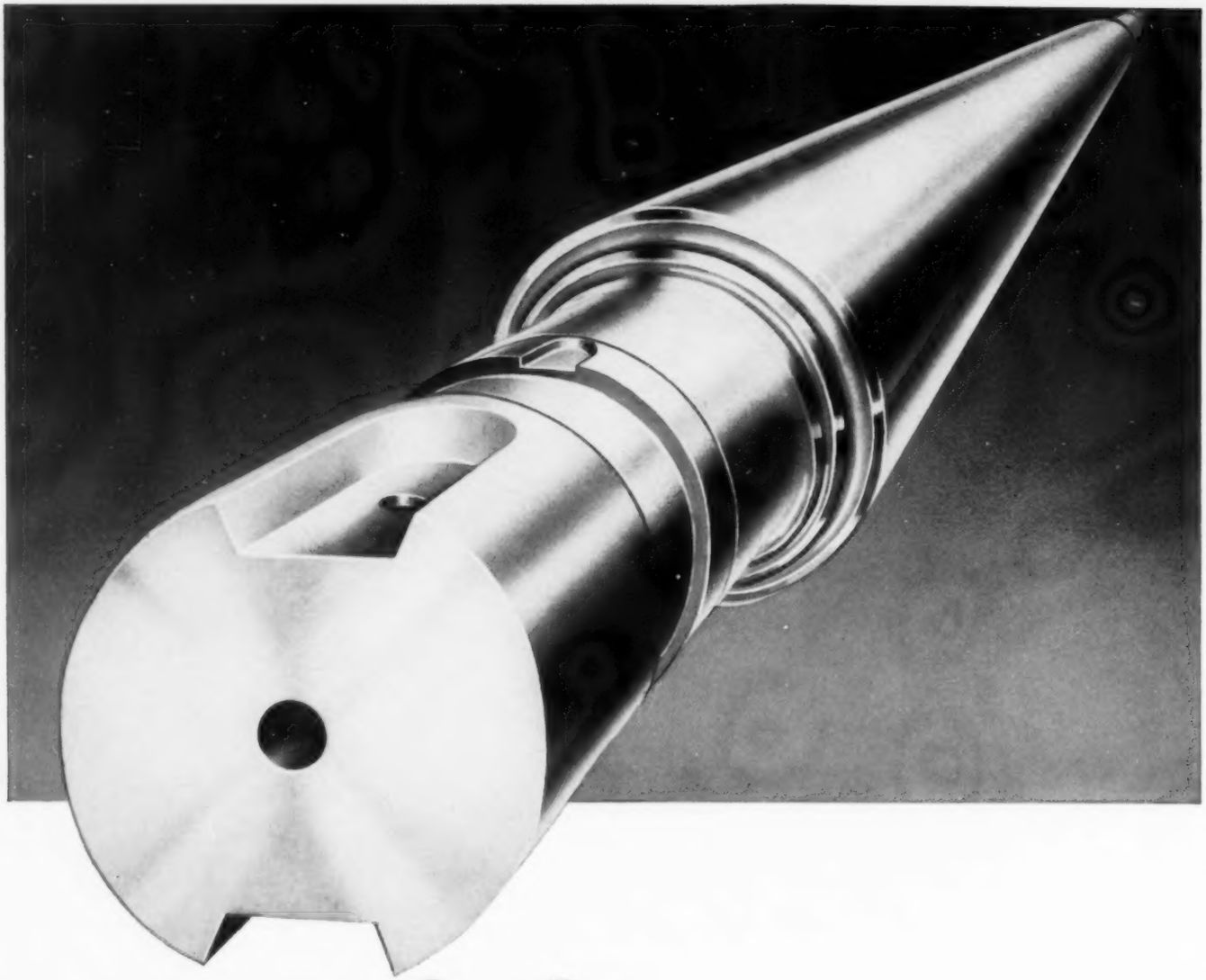
Markal PAINTSTIK MARKERS

PERMANENT • FADE-PROOF • WEATHERPROOF

Marks made years ago with Markal Paintstik Markers still are legible after continual exposure to the elements. Use of these Paintstik Markers has paid off by eliminating confusion and the need for remarking raw materials and finished products. Paintstiks created for marking on extremely hot metal surfaces up to 2100°F. make marks that do not peel, fade or char. Likewise, markings made with Paintstiks for cold surface marking stay legible under the most adverse weather conditions for any length of time.

Write your marking requirements on your letterhead.
A free sample of the Paintstik you need will be sent.

MARKAL COMPANY 3087 West Carroll Avenue • Chicago 12, Illinois



precision...

One of the unseen extra values you get in every NATIONAL ROLL

Yes, precision is an unseen value, but a very important one in roll production, because you must have precision machined rolls to give your customers precision and uniformity in rolled metals.

That's why National has always given such close attention to producing and machining rolls to exact specifications and close tolerances . . . and today, more than ever before, as a division of General Steel Castings, National has modern facilities plus additional metallurgical experience of the parent organization to give you rolls that will more than meet your expectations. Try National rolls and see.

NATIONAL ROLLS

GENERAL STEEL CASTINGS CORPORATION

NATIONAL ROLL & FOUNDRY DIVISION

Avonmore (Westmoreland County) Pennsylvania

General Steel Castings Corporation: General Offices, Granite City, Ill. • Plants: Granite City, Ill.—Eddystone, Pa.—Avonmore, Pa.

for lower maintenance

it's ohio magnets

Ohio Magnets cost less to maintain because they're built with an extra margin of safety. So for extra magnet life, extra magnet value—always specify Ohio Magnets and Ohio Magnet Controllers. There's a type and size for every lifting job. Send for free copy of Bulletin 112, or consult the Yellow Pages for Ohio offices in principal cities. AA-1476

THE OHIO ELECTRIC MFG. CO.
5400 DUNHAM ROAD • MAPLE HEIGHTS
CLEVELAND, OHIO

Ohio Also Makes Separation Magnets • Nail Making Machines • Fractional Horsepower, Shell and Torque Motors

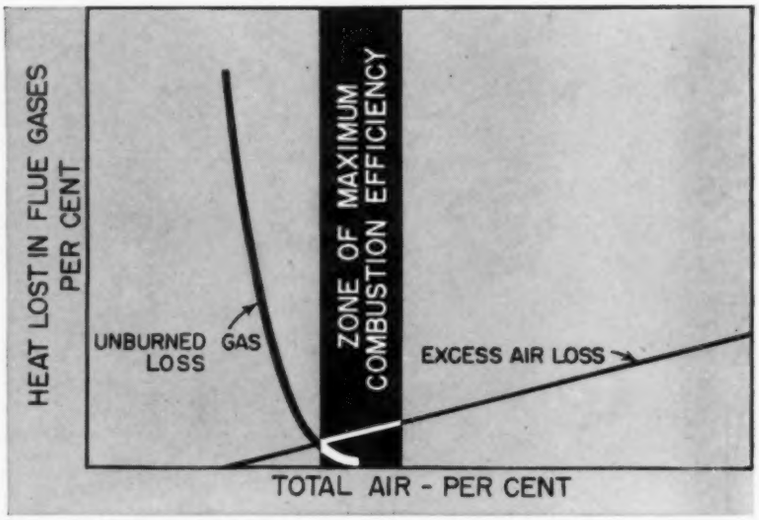
How to get maximum combustion efficiency . . . measure <u>both</u> combustibles and oxygen

Simultaneous measurement of both oxygen and combustibles is needed to obtain optimum combustion. No instrument that measures only one of these two interdependable factors can give you the full information necessary.

Now, Bailey offers two units, each giving a continuous and simultaneous double check on combustion efficiency: a permanent analyzer-recorder which records both factors on a single chart; and a new light weight, portable unit which indicates both factors.

Both instruments measure: (1) excess air—regardless of the fuel or combinations of fuel being burned, (2) mixing efficiency of your fuel burning equipment by showing per cent combustibles in the flue gas.

Both units are designed to increase efficiency in the furnace operations of the steel industry, on glass tanks, cement and lime kilns, ceramic and refractory kilns, steam boilers and also on direct and indirect-fired furnaces in the metal processing industries. To prevent your money from becoming waste gas, look into these two efficiency provers. A Bailey engineer will be glad to give you details or write us for product specifications.


HEAT LOST IN FLUE GASES PER CENT
UNBURNED GAS LOSS
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
EXCESS AIR LOSS
TOTAL AIR - PER CENT

Maximum Combustion Efficiency is secured by keeping the sum of Excess Air Loss and Unburned Gas Loss to a minimum. To do so by the direct method simply measure both oxygen and combustibles in flue gas.

For portable use—
HEAT PROVER Analyzer

The famous Cities Service HEAT PROVER analyzer is now Bailey built and sold. Weighing only 25 pounds, it is a self-contained automatic analyzer including a sampling tip and hose plus a thermocouple for temperature measurement.

Instrument dials are dual range for greater accuracy and sensitivity.

For permanent installation
Oxygen-Combustibles Recorder

The Bailey Oxygen-Combustibles Analyzer-Recorder coordinates both records on one chart. These records enable the operator to keep fuel burning equipment performing continuously in the zone of maximum combustion efficiency. Excess air may be reduced to the point where combustibles begin to show.

G 40-1

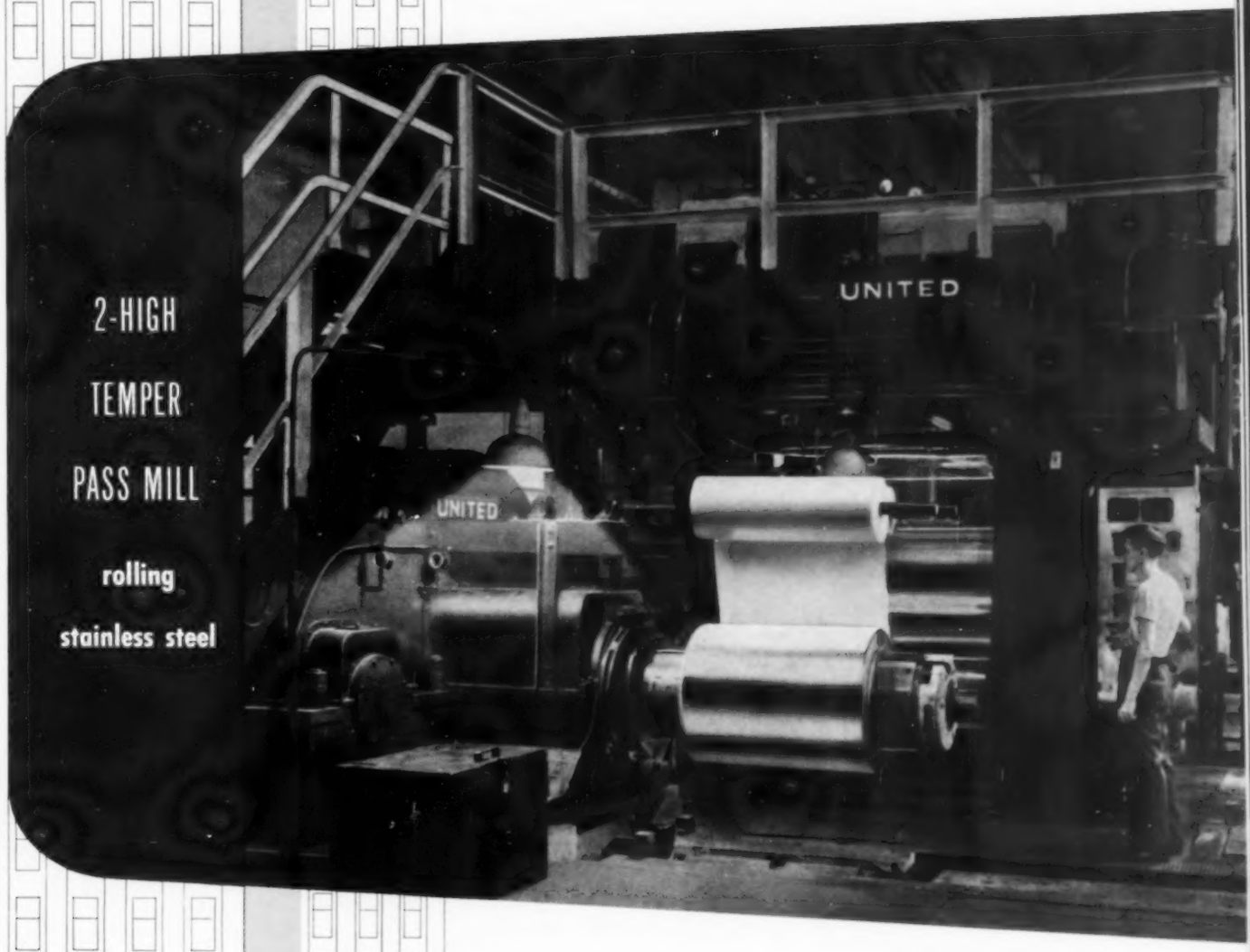
Instruments and controls for power and process

BAILEY METER COMPANY

1047 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS



2-HIGH
TEMPER
PASS MILL

rolling
stainless steel

STAINLESS STEEL BUILDING ENTRANCE

Designed and Built by

UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

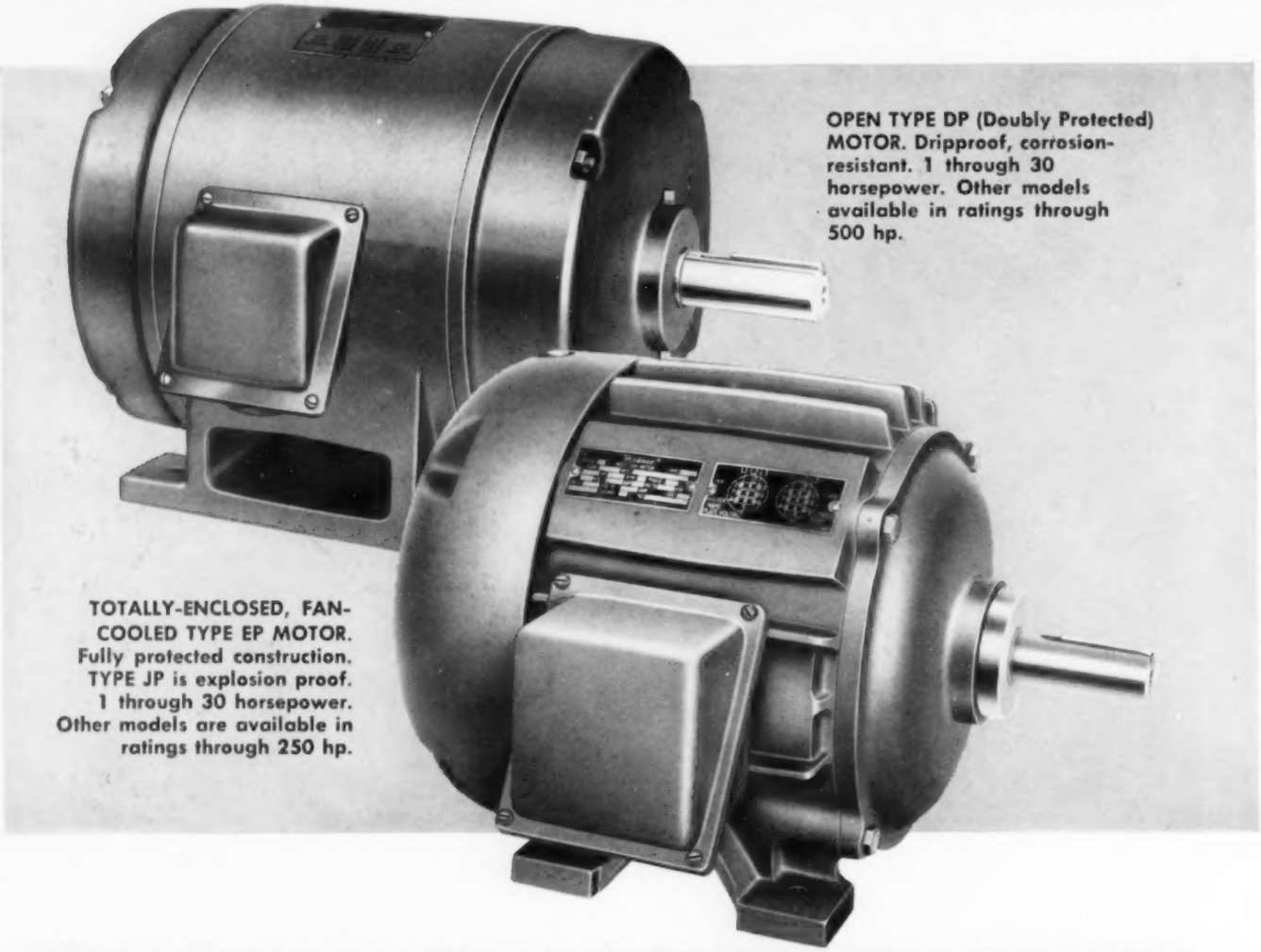
Plants at:
PITTSBURGH • VANDERGRIFT • YOUNGSTOWN • CANTON • WILMINGTON

Subsidiaries: **ADAMSON UNITED COMPANY, AKRON, OHIO**
STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

UNITED *can serve you no matter where in the world you are.*

WAGNER ELECTRIC MOTORS...THE CHOICE OF LEADERS IN INDUSTRY



OPEN TYPE DP (Doubly Protected) MOTOR. Dripproof, corrosion-resistant. 1 through 30 horsepower. Other models available in ratings through 500 hp.

TOTALLY-ENCLOSED, FAN-COOLED TYPE EP MOTOR. Fully protected construction. TYPE JP is explosion proof. 1 through 30 horsepower. Other models are available in ratings through 250 hp.

OPEN TYPE OR TOTALLY ENCLOSED MOTORS...

Wagner offers MORE for your motor dollar!

- **MORE POWER IN LESS SPACE**... These motors are built in NEMA frame sizes 182 through 326 U. They pack more power into less space for easier handling and stocking—require less space for installations.
- **CORROSION-RESISTANT FRAMES** ... Both types are built with rugged, corrosion-resistant cast iron frames. Motor feet are cast as an integral part of the frame for maximum strength and rigidity.
- **THE TYPE OF PROTECTION YOU NEED** ... Type DP motors have completely dripproof—virtually splash-proof enclosures; while type EP is totally enclosed, fan-cooled for complete protection; and type JP adds explosion proof features.
- **COOLER OPERATION**... Special baffles direct a cooling flow of air through the DP motor. Types EP and JP are fan-cooled and have ribbed frames to increase the surface area for more efficient cooling.
- **LONGER BEARING LIFE**... These motors can be re-greased when desired to prolong bearing life. Fresh grease can be added—old grease removed through openings provided in the bearing housing.
- **WAGNER DEPENDABILITY**... These two motors have the same high Wagner quality, will give the same long life performance, that have made Wagner Motors a known value for sixty-five years.
- Let a Wagner field engineer, expert on motor applications, show you how these motors can be applied to your needs. Call the nearest of our 32 branch offices, or write us. Bulletins MU-202 and MU-203 give complete information on these Wagner Motors. Write for your file copies today.

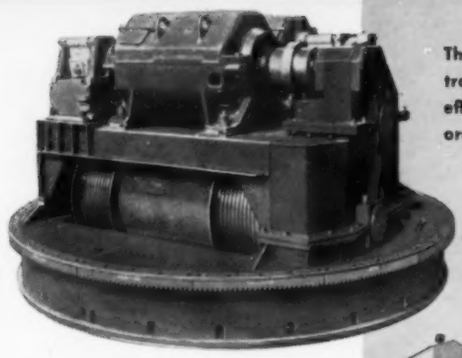
M57-4

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

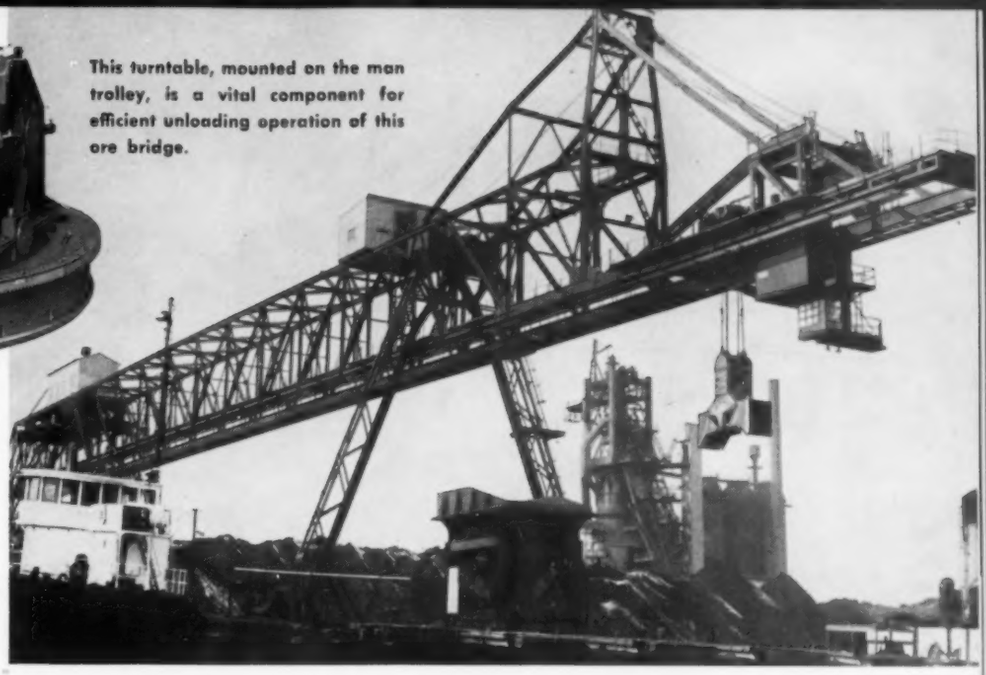
BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC



This turntable, mounted on the man trolley, is a vital component for efficient unloading operation of this ore bridge.



Ore Handling Brings to mind *Heyl & Patterson*

H & P BRIDGES HAVE THESE RECOGNIZED FEATURES:

- Wide flange beam construction to reduce dirt pockets.
- Adjustable voltage control for smooth trolley operation, for increased hoisting speed, for reduction of trolley weight, for drastically lowered power consumption.
- H & P special turntable for unloading bridges.
- Aluminum contact conductors.
- Fabreeka mountings for improving performance and lowering maintenance.
- Worm gear driven trucks—fully equalized.
- H & P automatic hydraulic rail clamps for bridge safety.
- H & P automatic hydraulic buffers for trolley safety.

WHY WE SAY: "When experience counts—count on Heyl & Patterson." Since 1905—when the name Heyl & Patterson first appeared on a traveling bridge—we have built MORE THAN 100 ORE AND COAL BRIDGES, with most of them still in daily service—even after 50 years of operation. AMONG THESE ARE:

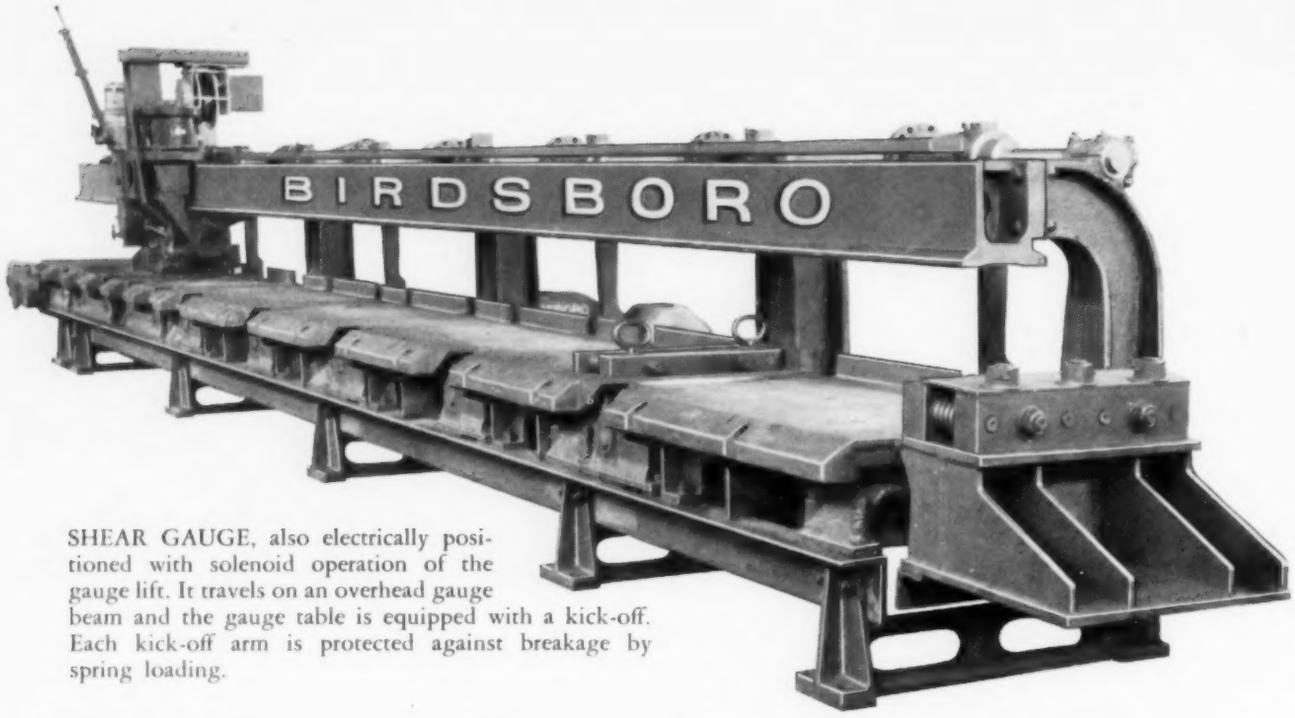
- **An H & P Bridge with the longest span—552 ft. (712 ft. overall).**
- **An H & P Bridge handling the largest bucket—22½ tons rated capacity.**
- **An H & P Bridge with the highest free digging capacity—over 1600 TPH carrying ore from center of stockpile to hopper.**

This long tradition of accomplishments, coupled with progressive engineering, has produced today's advances in H & P bridge designs. RECOGNITION OF THIS LEADERSHIP is the significant fact that we now have 4 ORE BRIDGES ON ORDER:

- **One 12 gross ton stocking and reclaiming bridge for a large West Virginia steel plant (the fourth H & P bridge for this customer).**
- **One 15 gross ton boat unloading, stocking and reclaiming bridge for a prominent Michigan steel company receiving ore by lake ore carriers.**
- **One 15 gross ton stocking and reclaiming bridge for an important Pennsylvania steel plant. This bridge will join another H & P ore bridge operating since 1953.**
- **One 20 gross ton boat unloading, stocking and reclaiming bridge for a leading Canadian steel plant on the Great Lakes.**

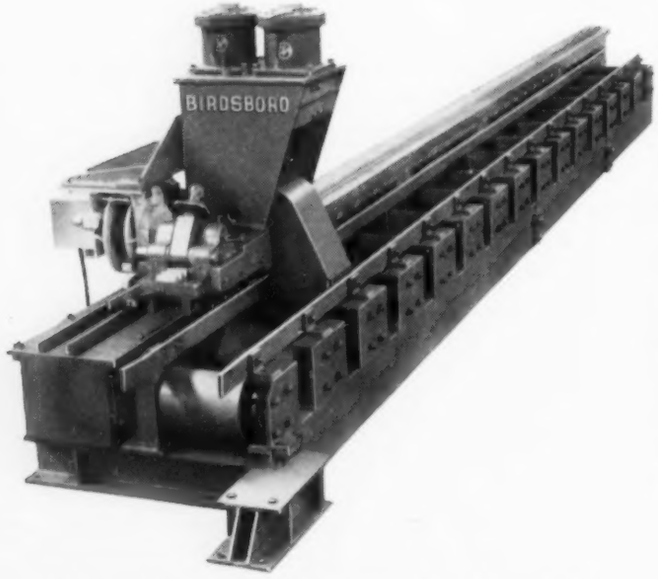
Heyl & Patterson
INC.
55 FORT PITT BLVD. • PITTSBURGH 22, PA.

When Experience Counts...
Count On Heyl & Patterson!



SHEAR GAUGE, also electrically positioned with solenoid operation of the gauge lift. It travels on an overhead gauge beam and the gauge table is equipped with a kick-off. Each kick-off arm is protected against breakage by spring loading.

Saw Gauge, Shear Gauge — Combining BIRDSBORO and CUSTOMER Ideas



SAW GAUGE, electrically positioned with solenoid operation of the gauge lift. The unit travels on a low beam and rack on top of the table lineshaft girder. The gauge head is spring cushioned. It is manually locked after positioning. This design is relatively compact and simple, and is suitable for lower tonnage operations.

• The saw and shear gauges pictured here are designed to perform the same operation, each in a different manner. Each machine turned out by Birdsboro is the combined result of the ideas of the buyer and the ideas and design skills of the builder. For an exchange of ideas on your mill equipment problems, contact Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa., District Office: Pittsburgh, Pa., Subsidiary: Engineering Supervision Co., 120 W. 42nd St., New York 36, N. Y.

MM57-57

BIRDSBORO

STEEL FOUNDRY AND MACHINE CO.

STEEL MILL MACHINERY • HYDRAULIC PRESSES (Metalworking and Extrusion) • CRUSHING MACHINERY • SPECIAL MACHINERY • STEEL CASTINGS • "CAST-WELD" Design • ROLLS: Steel, Alloy Iron, Alloy Steel

VS-100 new all-electric machine tool feed drive

No pick-off gears or gear changes are necessary with the VS-100. Infinitely variable 100 to 1 speed range offers high speeds for rapid traverse as well as the slowest feed rates.

Feeds may be precisely selected and rapidly changed, even during a cut. The push button operator's station provides easy, instantaneous feed control. This remote station contains controls for start, stop, jog, reverse, and speed changing . . . ideal in pendent station mounting for maximum operator's convenience. Additional functions, such as automatic dwell and automatic feed programming are available for the operator's station.

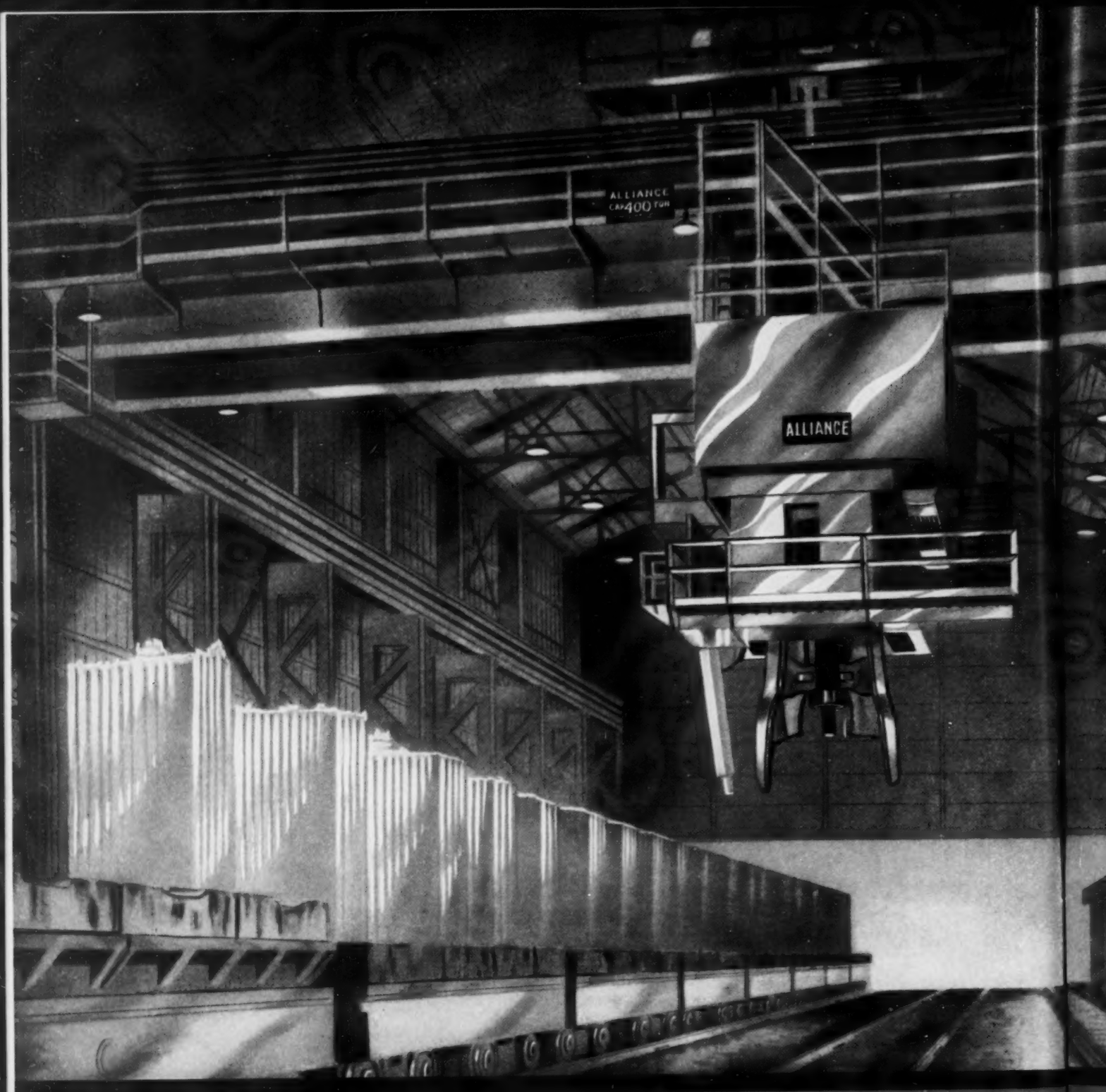
The VS-100 operates from 220 or 440 volt, single phase, a-c. circuits. Seven sizes are available ranging from ½ thru 4 horsepower. For complete details write for bulletin D-2501. D-1540

RELIANCE R ELECTRIC

AND ENGINEERING COMPANY

DEPT. 114A CLEVELAND 17, OHIO • CANADIAN DIVISION: WELLAND, ONTARIO

Sales Offices and Distributors in Principal Cities



THE WORLD'S LARGEST STRIPPER CRANE

• This 400-ton Alliance push-pull Stripper Crane is the world's largest. It can exert 2,400,000 pounds' pressure to strip moulds from ingots — cleanly and safely. The patented Impact Stool Loosener speeds up the stripping operation. The stripping mechanization has a nominal rating of 400 tons but is designed to stand forces of 1200 tons. Its many exclusive design features are a result of Alliance's knowledge of mill problems and requirements. They design the world's biggest cranes, manipulators and special machinery. Their experience assures you the best in modern design. A letter, wire or phone call will put your problems into the hands of The World's Largest Builders of the World's Largest Cranes.

THE ALLIANCE MACHINE COMPANY

EXCLUSIVE with ALLIANCE

The Alliance Impact Stool Loosener makes your stripper crane more useful, more efficient and saves wear and tear on the crane and ingot buggies. The Impact Stool Loosener can be installed on most stripper cranes now in your service.

Alliance

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHERS

MAIN OFFICE • ALLIANCE, OHIO

STEARNS LIFTING MAGNETS...

handle 100 tons daily at Verson

With pinpoint accuracy, a 45-inch Stearns lifting magnet easily positions a seven-ton steel plate on the pantograph flame-cutting table in the big shops at Verson Allsteel Press Company. Layout man simply guides operator, never needs to handle hoisting equipment.

Two Stearns 45-inch lifting magnets on 15-ton cranes really get a workout at Verson Allsteel Press Company, Chicago manufacturer of metal forming presses.

Typical of modern methods at Verson, the powerful magnets handle up to 100 tons of raw and finished steel daily. One man directs stock moving.

Veteran layout man Leo Potocki recalls the days when heavy steel plates were secured with awkward clamps that had to be positioned carefully for safe lifting. As Leo says, "There's just no comparison! We used to waste so much time hooking up or releasing loads — now the big Stearns magnet just comes down onto the steel and it's ready to lift right away!

"All I have to do is show where I want the load — the operator does all the rest."

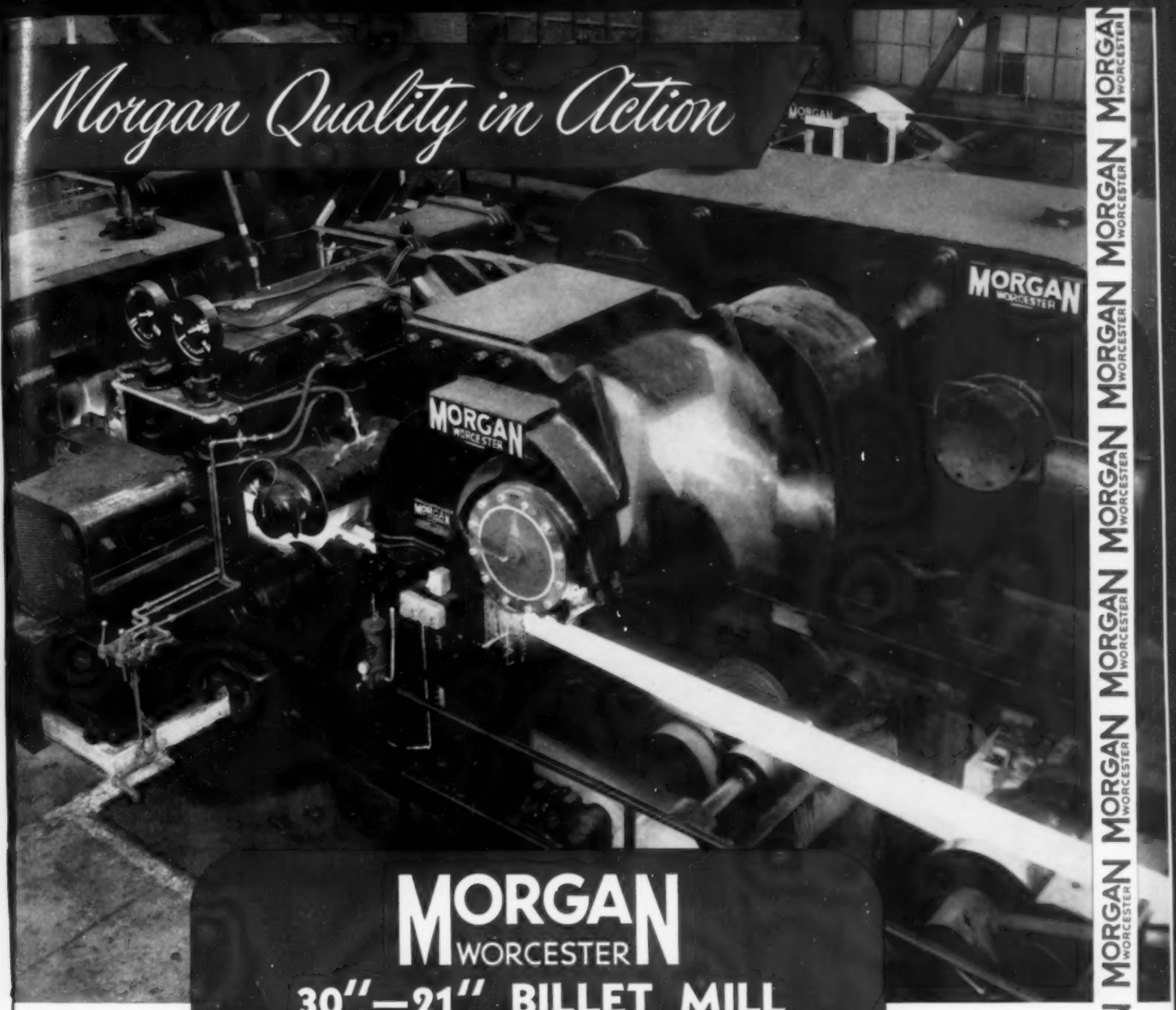
Like Verson Allsteel Press Company, modern plants in many industries have found that Stearns lifting magnets increase material handling efficiency, speed production, save time and labor. Stearns builds both rectangular and circular lifting magnets for any application, with capacities to match your requirements. Write today for free literature. Ask for Bulletin 35-CI. 28

STEARNS MAGNETIC PRODUCTS

635 SOUTH 28TH STREET • MILWAUKEE 46, WISCONSIN

This advertisement appears in: Iron & Steel Engineer, April, 1957

Morgan Quality in Action



MORGAN WORCESTER

30"—21" BILLET MILL

with No. 5 Electric Flying Shear in Action

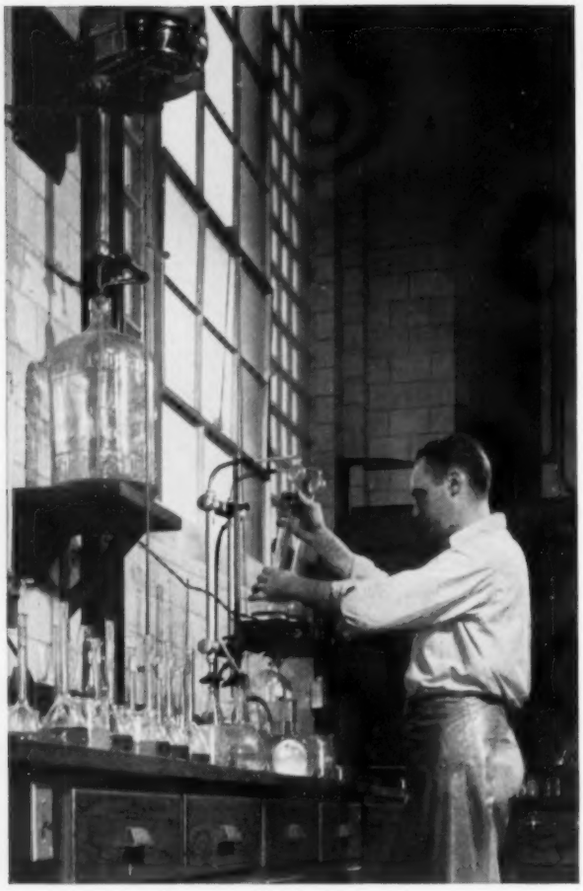
Every Morgan Mill is developed by highly skilled technical engineers to answer the exacting demands of mass production. Morgan introduced the first successful continuous rolling mill in this country—and has consistently maintained leadership in producing quality, high production mills in this country and abroad.

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

ROLLING MILLS MORGOIL BEARINGS GAS PRODUCERS
WIRE MILLS EJECTORS REGENERATIVE FURNACE CONTROL

MORGAN WORCESTER MORGAN WORCESTER MORGAN WORCESTER

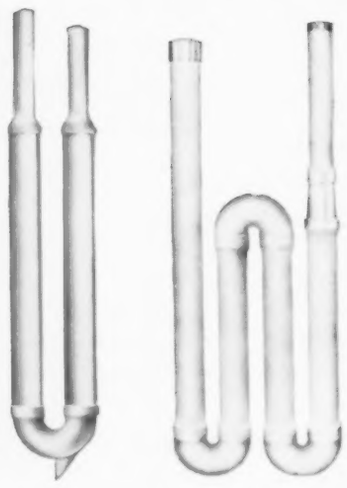


THIS IS A FOUNDRY?

Looks more like a chemical lab, doesn't it? And that's exactly what it is—in the Electro-Alloys plant at Elyria. It's typical of our complete research and metallurgical facilities—which also include X-ray and physical testing laboratories.

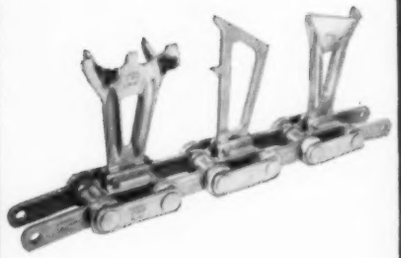
Out of research and metallurgical facilities like this has come the reputation of THERMALLOY* heat-resistant castings—for long-life economy in scores of steel mill applications. Just a few of these are shown below. Your nearby Electro-Alloys representative will be glad to give you full information about them, and many more . . . or assist you with any high-heat-resistant casting problem you may have. Why not call him?

*Reg. U. S. Pat. Off.



Thermalloy Radiant Tubes
Centrifugally cast, X-ray controlled, pressure-tested.

Thermalloy Furnace Rolls
...for roller-bottom furnaces.



Thermalloy Carrier Blades and Chain...Three types of blades, mounted on *Thermalloy* conveyor chain.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION Elyria, Ohio

Patent Reviews

By
MELVIN NORD
Patent Attorney
Detroit, Mich.

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C. at 25 cents . . . . patents reviewed cover period November 6, 1956 through November 27, 1956 . . . .

MARKED ELECTROLYTIC TINPLATE

▲ The commercial tinplate now produced has the same amount of tin on each surface, yet a large saving of tin could be effected if the outer surface contained a thinner coat than the inner surface. However, if this were done, the manufacturer would not be able to determine which surface should be the inner surface of a container. Marking tinplate by means of a die that deforms the metal is not satisfactory as it destroys a portion of the sheet. Marking ink cannot be used, as the ink tends to spread and smear at the high speeds involved. The ink may also be removed by the subsequent treatments (e.g., cathodic electrolytic treatment and washing and oiling treatments). Ink also tends to transfer from the marked to the unmarked surface during coiling, and it tends to darken when the tinplate is subsequently coated with lacquer and baked, thus presenting an unsightly appearance.

U. S. 2,770,872, issued November 20, 1956, to Alfred E. Kadell and assigned to National Steel Corp., provides a solution to this marking problem. The method involves interference with the flow-brightening process in such a way that the "marked" portions of the tin coating will have different, visible, light reflecting characteristics than the rest of the flow-brightened surface.

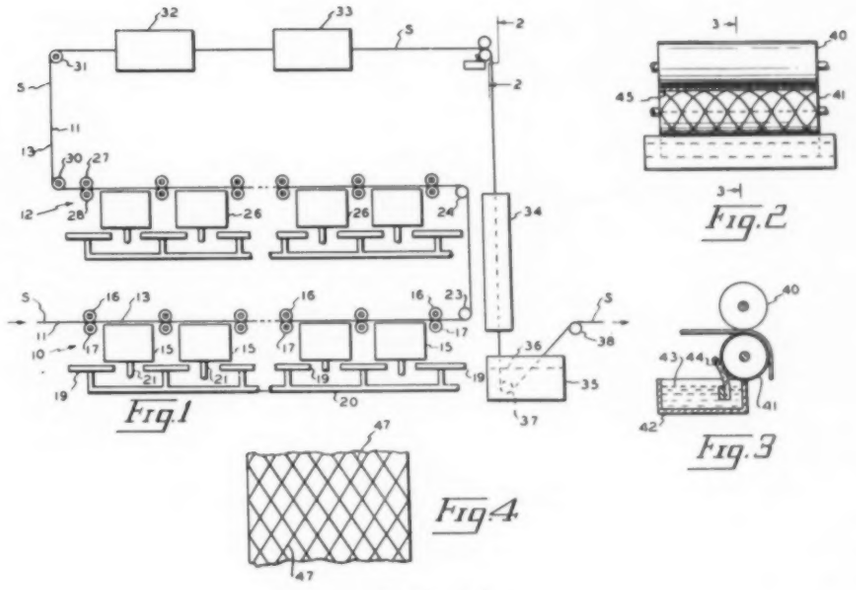


Figure 1–4

As shown in Figure 1, the electroplating line includes apparatus 10 for electroplating the bottom surface 11 of strip S with a coating of tin and other apparatus 12 for electroplating the opposite surface 13 of the strip S with a coating of tin. The apparatus for electroplating the bottom surface includes a series of similar electroplating cells 15. Between each two cells 15 and at the entry and exit ends of the series of cells, there are a pair of strip-engaging rolls 16 and 17. One of the rolls, usually the upper roll, is a contact roll and is connected to one side of the source of the electroplating current so as to connect strip S to a source of electroplating current as a cathode. The other roll 17 is a backup roll holding the strip in contact with the upper roll 16. The rolls may or may not be driven. The cells 15

are of the type which contain a bath of electroplating solution and a plating anode connected to the source of electroplating current as anode. The strip S moves across the top of the cells where the bottom surface 11 is in contact with the electroplating solution in each cell. As the strip moves across the series of cells, a coating of tin is applied to the bottom surface 11.

At the entry and exit ends of the series of cells 15 and between each two cells there is a collecting tray 19 which collects the solution flowing out of the cells and this solution is returned through piping 20 to a collection tank, and is then pumped back into the cells through pipe 21. As the strip leaves the lower apparatus 10, it passes around a roll 23 and then up and around an upper roll 24 and then across the upper electroplating apparatus for electroplating the opposite surface 13 which is now facing downwardly. The apparatus 12 is similar to the apparatus 10, but permits a different thickness of coating to be plated on to the second surface.

After passing over the upper series of cells, the strip passes around roll 30, then up and around roll 31 to a washer 32 and through a dryer 33. As the strip moves through the flow-brightener 34, it is heated to a temperature above the melting point of tin. From the bottom of the flow-brightener, the strip passes around roll 37 and then up to roll 38. The strip then passes to units for subsequently treating the strips and then to the usual coiler.

As shown in Figures 2, 3, and 4, the strip which has been washed and dried, and which has a matte finish, is passed between rolls 40, 41. The lower roll is mounted above a tank 42 containing a bath of palm oil 43. In the tank there is mounted a wick 44 which extends down into the bath 43 and which contacts the surface of the rubber roll 41. The surface of roll 41 has raised portions arranged in lines 45. Thus, as the strip moves between rolls 40 and 41, palm oil from bath 43 is deposited in the form of intersecting lines on the strip. As the strip subsequently moves through the flow-brightener 34, the palm oil interferes with the flow-brightening so as to produce a flow-brightened tin coating in the marked zones that has a different light-reflecting characteristic than the remainder of the sheet. The reason for this is that a portion of the palm oil vaporizes, so that the underlying tinplate is heated to a lower temperature than the rest of the tin. In addition, palm oil has some fluxing or etching action on the tin surface.

OPEN-HEARTH REGENERATOR

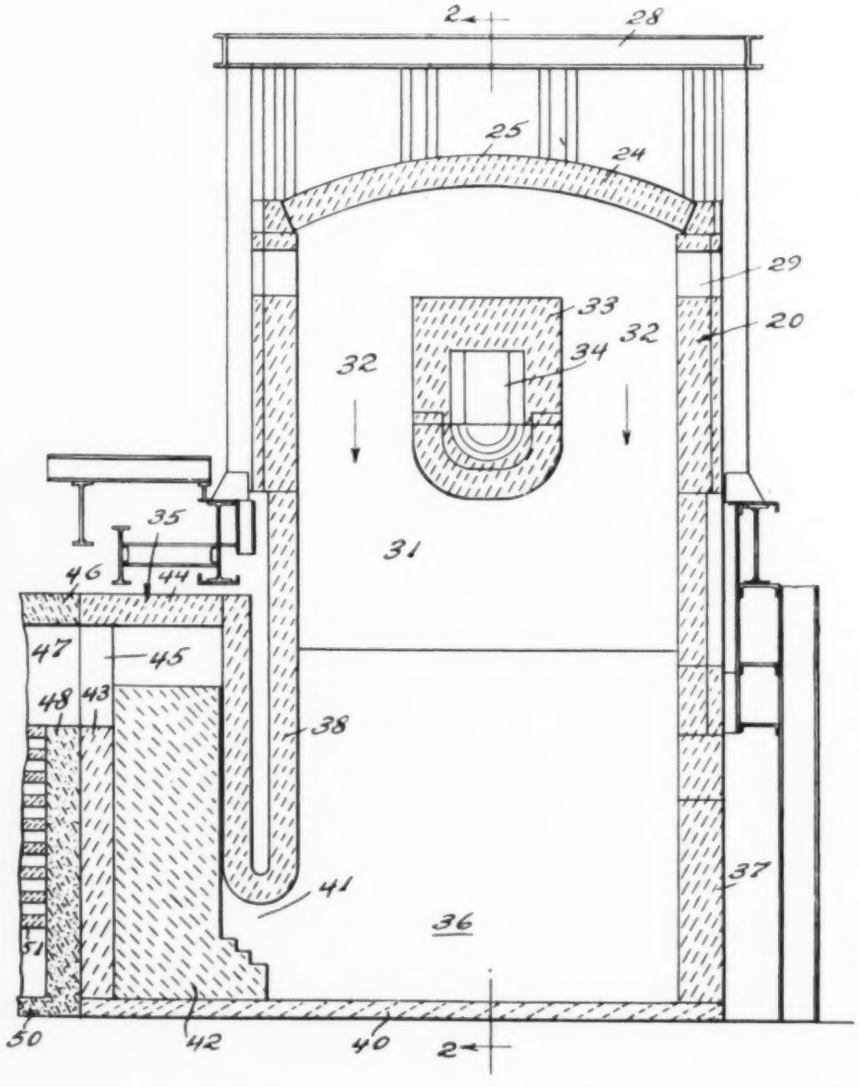
▲U. S. 2,771,285, issued November 20, 1956 to General Refractories Co., describes an open-hearth regenerator, in which clogging with flue dust is reduced and in which higher temperatures are possible.

The refractory parts encountered by the flue gases as they enter the regenerator are constructed of non-acid refractory brick, rather than silica or fireclay as in previous practice. The heat is first absorbed from the flue gases by the non-acid refractory housing and by non-acid refractory heat absorbers. At a later point the flue gases are passed through fireclay checkers.

The regenerator is shown in Figures 5 and 6. Immediately beyond the curtain wall 38 (Figure 5) is a multiple-flue vertical pass non-acid refractory brick heat absorber 42 (Figures 5 and 6). This consists of a series of magnesia or chrome refractory brick separating walls 42′ breaking the gas flow up into many different small passages and providing intimate contact between the hot gases and the walls 42′. A magnesia or chrome refractory checker wall 43 rises from the bottom of the regenerator to a point below the regenerator roof 44, which is also of non-acid refractory.

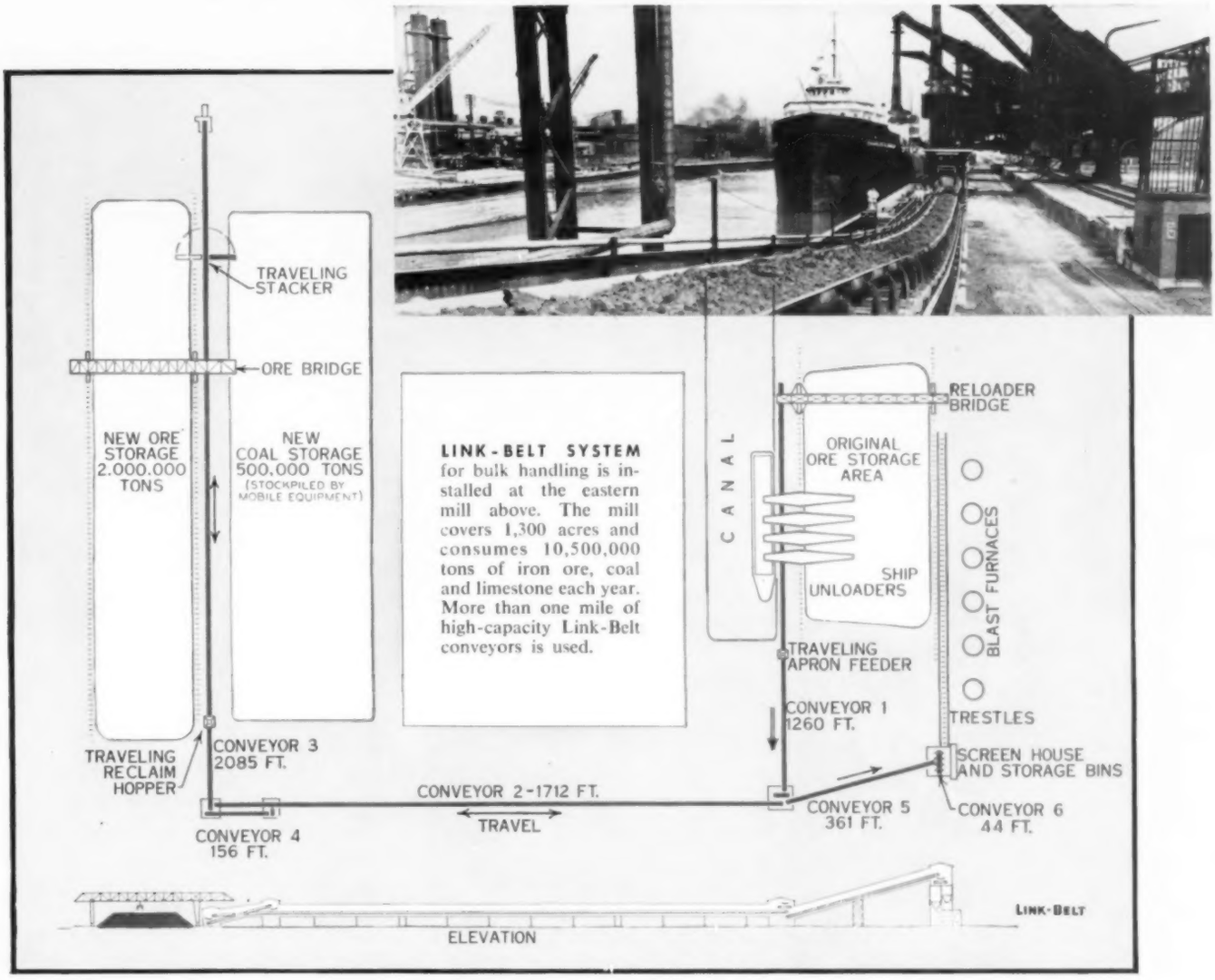
Thus, where the gases are the hottest, they are in contact only with non-acid refractory brick, but

Figure 5



How LINK-BELT raw materials handling systems

keep pace with today's burdening techniques


TRAVELING STACKER
ORE BRIDGE
NEW ORE STORAGE 2,000,000 TONS
NEW COAL STORAGE 500,000 TONS (STOCKPILED BY MOBILE EQUIPMENT)
LINK-BELT SYSTEM for bulk handling is installed at the eastern mill above. The mill covers 1,300 acres and consumes 10,500,000 tons of iron ore, coal and limestone each year. More than one mile of high-capacity Link-Belt conveyors is used.
CANAL
RELOADER BRIDGE
ORIGINAL ORE STORAGE AREA
SHIP UNLOADERS
BLAST FURNACES
TRAVELING APRON FEEDER
CONVEYOR 1 1260 FT.
TRESTLES
SCREEN HOUSE AND STORAGE BINS
TRAVELING RECLAIM HOPPER
CONVEYOR 3 2085 FT.
CONVEYOR 2 - 1712 FT.
TRAVEL
CONVEYOR 4 156 FT.
CONVEYOR 5 361 FT.
CONVEYOR 6 44 FT.
ELEVATION
LINK-BELT

Meet the demands of greater blast furnace output with improved conveying efficiency

MODERN, more productive blast furnace burdening techniques—developed in answer to growing steel demand—have multiplied problems of storing and reclaiming bulk materials. Higher tonnages, more extensive storage areas, separate stockpiles for a greater number of individual ores—all increase the importance of integrated, high-capacity materials handling.

As one of industry's largest, most experienced conveying specialists, Link-Belt offers one source for engineering and equipping such systems for both new and expanding mills. Systems designed to make the most of existing space . . . handle increased capacities.

Our engineers are available to work with your own staff and consultants in mechanizing raw materials flow at your mill. Your nearest Link-Belt office will be glad to arrange a consultation at your convenience. 14,553

LINK-BELT

MATERIALS HANDLING, PROCESSING AND POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

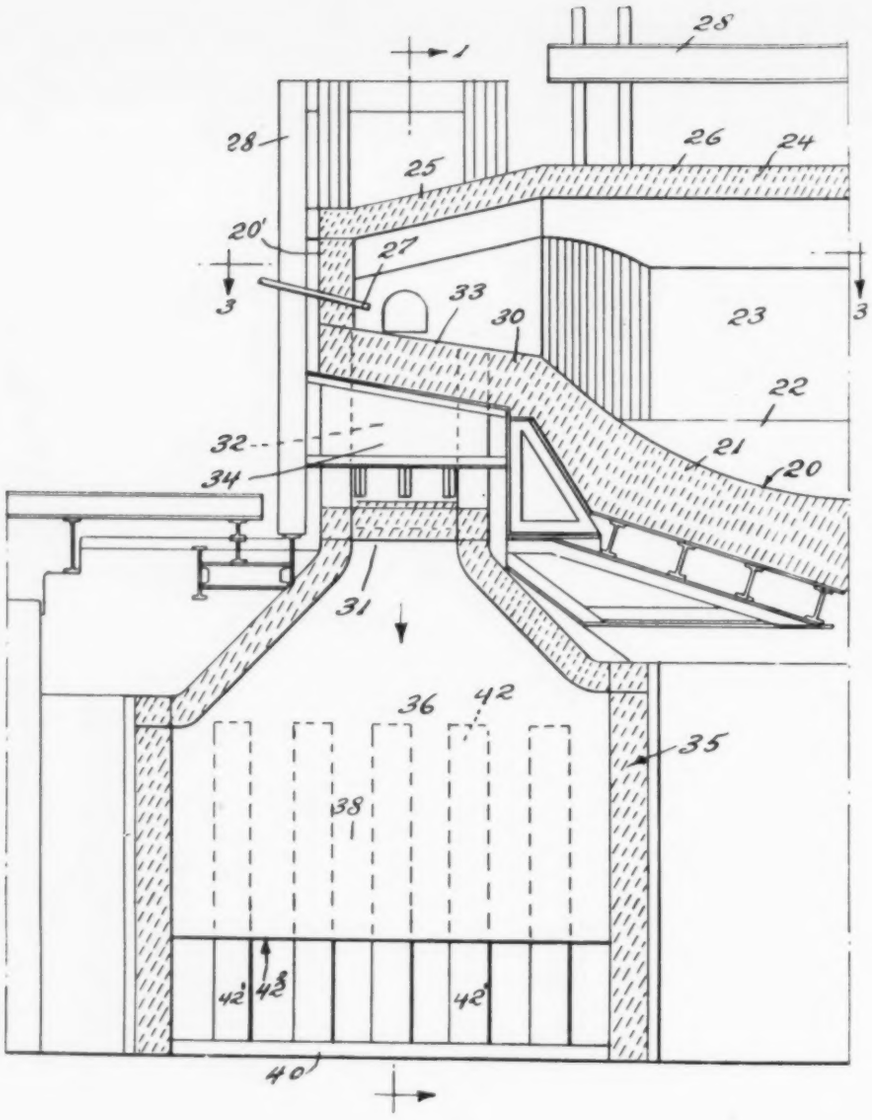


Figure 6

beyond this point, the roof 46, side wall 47 of the housing, checker wall 48, bottom wall 50, and checker 51 are all of fireclay brick.

The fact that the non-acid refractory is not susceptible to corrosive attack as in the case of silica and fireclay, makes it possible to operate at higher temperatures and with less care to the checker.

AGGLOMERATING ORES IN THE BLAST FURNACE

▲U. S. 2,771,355 issued November 20, 1956 to Harry Cohen, describes a process for agglomerating iron ores in the blast furnace, in order to avoid blowing fine ore out the top of the furnace.

A cementing agent in suspension, emulsion, or solution, is added to the water which is sprayed on the ore. For example, 0.1 to 10 per cent of a 40° Bé sodium silicate solution may be used. A surface tension depressant or wetting agent may also be added to improve the wettability of the ore.

DEOXIDATION OF SEMI-KILLED STEEL

▲U. S. 2,771,356 issued November 20, 1956 to Willard A. Carlson and assigned to United States Steel Corp., describes a method of deoxidizing semi-killed steel to produce a highly homogeneous ingot structure and reduce laminations in plate rolled from it. The method consists chiefly of using a deoxidizing ladle addition of silicon carbide (SiC).

The open-hearth charge is oxidized until its carbon content is 0.12 to 0.15 per cent. Sufficient ferrosilicon and sodium nitrite oxidizer are added to prevent gas evolution. Then, enough high-carbon ferromanganese is added to satisfy the composition requirements of carbon and manganese. After these additions, the steel is tapped. The steel is then further deoxidized in the ladle by the addition of silicon carbide in an amount corresponding to 0.025 to 0.045 per cent of the weight of steel in the ladle of silicon, and adjusting the manganese concentration.

Following this, the steel is teemed into ingot molds, and during teeming a small amount of shot aluminum is added to bring the deoxidation to a point where the steel will rise in the molds to form a slightly convex upper surface.

PREPARATION OF NON-AGING STEELS

▲ U. S. 2,771,651 and 2,772,154 issued November 27, 1956 to Eric R. Morgan and John C. Shyne, assigned to Ford Motor Co., describe a process for the manufacture of rimmed chemically capped steel suitable for the production of deep drawn parts. The process permits the consistent economic production of steels in a non-aging condition.

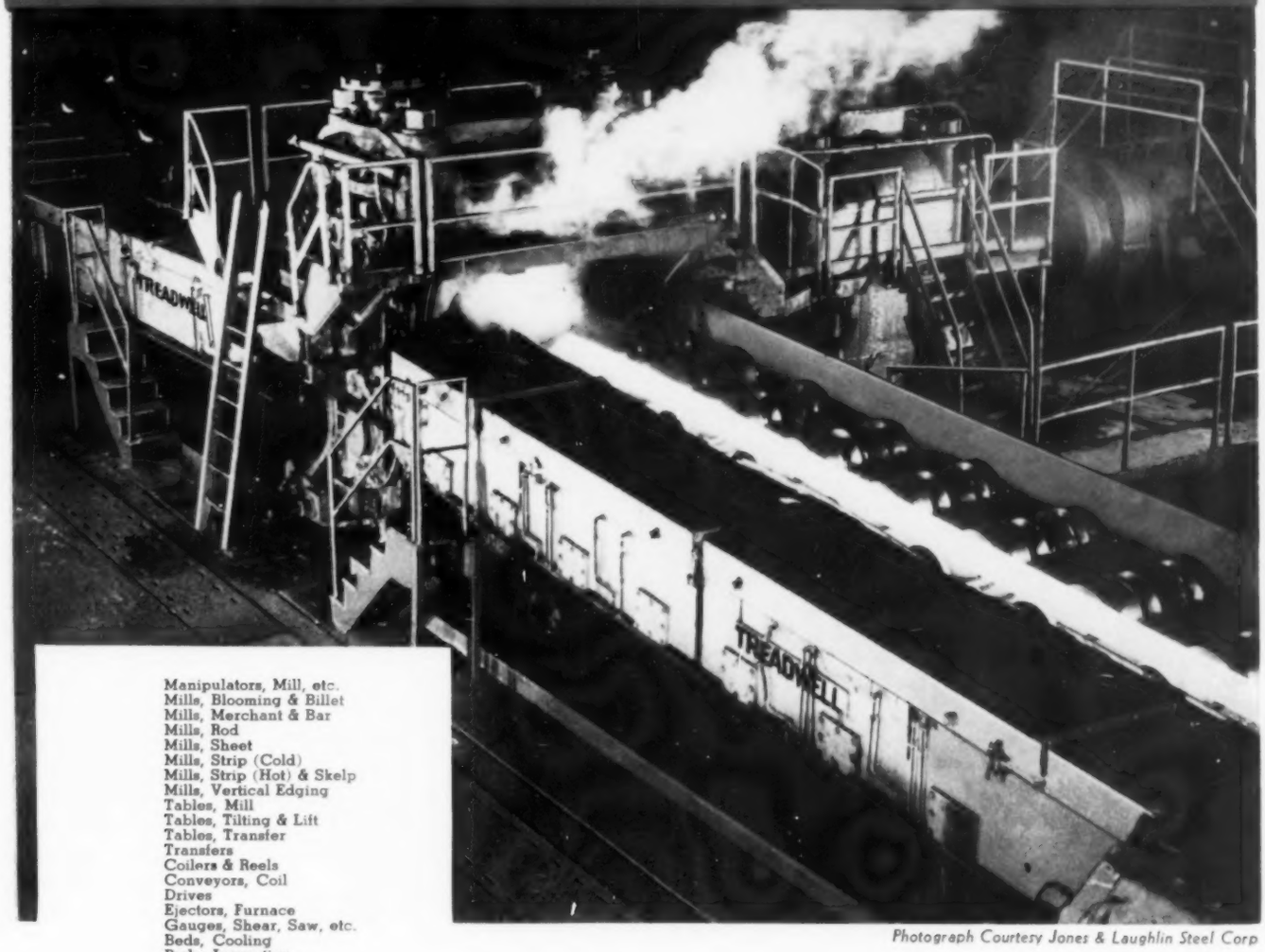
The first step in the process is the establishment in a mold of a mass of molten steel of rimming composition and containing a small addition of ferro-boron, in amount which is sufficient only to inhibit slightly the usual vigorous rimming action. The rimming action is allowed to continue until a skin has been formed on the exterior of the ingot. The ingot is then chemically capped by the addition of aluminum shot. The top of the ingot is thoroughly stirred after the addition of the aluminum. The steel is finally alloyed with enough boron to yield a final boron content of 0.002 to 0.02 per cent.

BENEFICIATION OF IRON ORES

▲U. S. 2,769,541 issued November 6, 1956 to Richmond E. Perry and assigned to United States Pipe and Foundry Co., describes a flotation process for beneficiating limonite ores.

An aqueous pulp of the ore is first activated with hydrated lime

Treadwell



Photograph Courtesy Jones & Laughlin Steel Corp

Manipulators, Mill, etc.
Mills, Blooming & Billet
Mills, Merchant & Bar
Mills, Rod
Mills, Sheet
Mills, Strip (Cold)
Mills, Strip (Hot) & Skelp
Mills, Vertical Edging
Tables, Mill
Tables, Tilting & Lift
Tables, Transfer
Transfers
Coilers & Reels
Conveyors, Coil
Drives
Ejectors, Furnace
Gauges, Shear, Saw, etc.
Beds, Cooling
Beds, Inspection
Bumpers, Furnace
Pushers, Furnace
Repeaters
Handling Equipment (Kick-offs, Pilers, Cradles, etc.)
Steel and Iron Castings
Ni-Hard and Ductile Iron Castings

40′ long 28″ three-hi mill tilting tables for diamond and square pass rolling of bars, billets and blooms. Materials automatically manipulated from pass to pass with manipulators. Our Engineers will be glad to discuss your mill problems with you.

BETTER GRADE MACHINERY

Treadwell Engineering Company

EASTON, PA.

SALES AND ENGINEERING OFFICES:

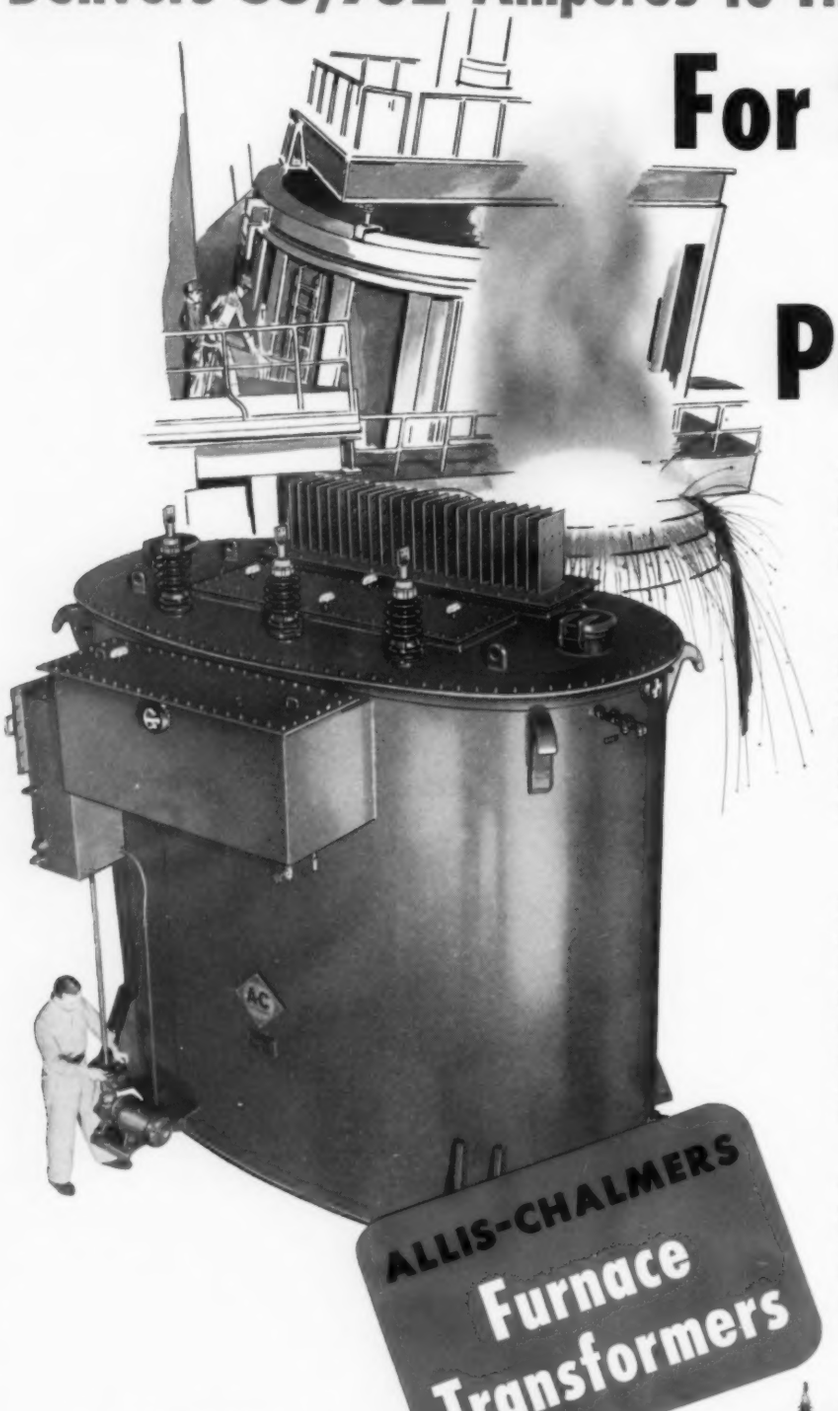
208 S. LA SALLE STREET
CHICAGO 4, ILL.
CEntral 6-9784

140 CEDAR STREET
NEW YORK 6, N. Y.
WOrth 4-3344

1015 FARMERS BANK BLDG.
PITTSBURGH 22, PA.
ATlantic 1-2883

Delivers 33,962 Amperes to The Timken Company

For Specialized Steel Production



This is one of three arc furnace transformers built by Allis-Chalmers for The Timken Roller Bearing Company, Canton, Ohio, plant.

The repeated daily short circuits encountered in arc furnace operation require exceptionally rugged transformers that can provide reliability over long periods. That's one reason Allis-Chalmers furnace transformers are chosen for jobs like this. They have served many furnaces for as much as 25 to 30 years.

Design Features

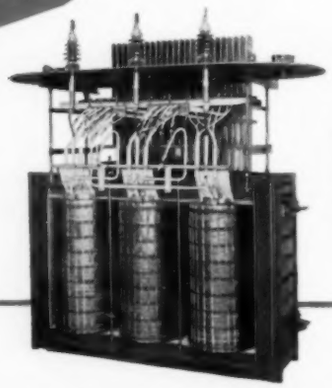
Extremely heavy supports brace the coils against short circuit stresses in these transformers. Skillful insulation techniques protect windings from overvoltages due to wide tap range. Some of these transformers have been built with a range of operating voltages of several times the minimum secondary voltage.

The tap changer has specially designed contacts to provide for long life regardless of numerous daily tap changes. The mechanism is located in a separate compartment to facilitate inspection. It can either be motor driven or manually operated or both.

Complete Line of Arc Furnace Equipment

In addition to furnace transformers in ratings up to the largest demanded by expanding arc furnace operation, Allis-Chalmers also builds electrical control, circuit breakers, and auxiliary transformers. Next time you need new or replacement arc furnace electrical equipment, consult the Allis-Chalmers office nearest you or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4750



Rugged Core and Coil Assembly design is based on Allis-Chalmers more than 45 years' experience building arc furnace transformers. Unit must withstand repeated short circuits.

ALLIS-CHALMERS

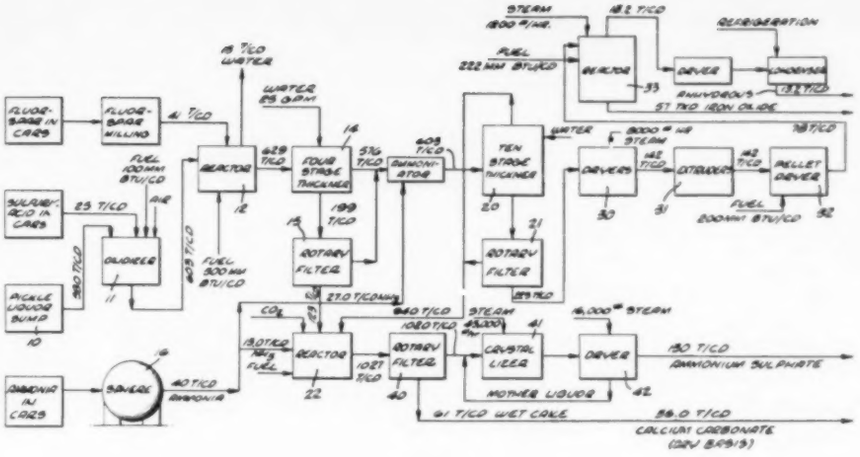


Figure 7

and conditioned with sodium hydroxide. The activated and conditioned pulp is then treated with a petroleum oil in the presence of an anion-active collecting agent such as tall oil, and the iron values are then floated in a flotation apparatus.

TREATMENT OF WASTE PICKLE LIQUOR

▲U. S. 2,769,689 issued November 6, 1956 to Gustave E. Kidde and assigned to Kidde Process Corp., describes a process for the production of hydrogen fluoride, hydrofluoric acid, ammonium sulphate, ferric oxide, and other valuable chemicals from waste pickle liquor.

As shown in Figure 7, the pickle liquors are collected in a sump 10, where entrained solids are allowed to settle out. The clear effluent is then pumped to one of two oxidizers 11, where it is mixed with sulphuric acid and then blown with hot air and steam until all ferrous ions have been converted to the ferric state. The oxidized liquor is then pumped to the agitated reactor 12.

Fluorspar is dried and ground, and fed to the reactor 12—the end product of reaction with the oxidized liquor being a soluble complex of iron fluorine and sulphate, a soluble ferric sulphate and a precipitate of calcium sulphate. These reaction products are washed countercurrently in thickeners 14, the thickener underflow (calcium sulphate) being dewatered by filtration on a rotary filter 15 and fed to the reactor 22 for ammonium sulphate production.

The thickener overflow is combined with the filtrate from filter 15 and reacted with gaseous ammonia from the storage sphere 16. The soluble compounds are thus converted to insoluble ferric fluohydroxide, insoluble ferric hydroxide and soluble ammonium sulphate. The reaction products are water-washed in a multi-stage thickener 20 and the underflow therefrom is dewatered on a rotary filter 21. The filtrate and the thickener overflow (ammonium sulphate solution) are mixed and fed to reactor 22 for conversion to solid ammonium sulphate.

The filter cake from the filter 21 is mixed and partially dried in a steam dryer 30 and then extruded in auger extruders 31 to produce pellets which are then dried in drier 32. The pellets are then thermally decomposed in a reactor 33 at a temperature of 1000 C, breaking down the fluorine complex into hydrogen fluoride gas and iron oxide. Upon cooling, the iron oxide is suitable for use in the blast furnace or for other uses. The hydrogen fluoride is cooled, dried, and condensed, the liquid product being stored in refrigerated tanks, from which it is shipped in bulk or in pressure cylinders.

The calcium sulphate is converted into marketable ammonium sulphate by reaction with ammonia and carbon dioxide in reactor 22, yielding soluble ammonium sulphate and insoluble calcium carbonate. The mixture is filtered in filter 40. The high purity calcium carbonate can be used in the blast furnace as flux, converted to lime in a kiln, or used in other industrial chemical operations.

The filtrate of ammonium sulphate is crystallized in a crystallizer 41 and dried in a centrifuge-drier 42.

OTHER PATENTS OF INTEREST TO THE IRON & STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,769,424	11/6/56	Apparatus for coating metal articles	Wheeling Steel Corp.
2,769,425	11/6/56	Liquid bath type furnace	Oscar R. Olson
2,769,629	11/6/56	Baffle wall construction for rotary hearth furnaces	Salem-Brosius, Inc.
2,769,630	11/6/56	Annealing tightly wound coils of strip steel	John D. Keller
2,769,690	11/6/56	Inhibiting corrosion of ferrous metals	Phillips Petroleum Co.
2,769,691	11/6/56	Production of sulphur and hydrogen from iron sulphides	Pietro Achille
2,769,735	11/6/56	Method of pickling iron and recovering pickling agent	Cleveland Industrial Research Inc.
2,770,021	11/13/56	Apparatus for continuous casting	The Babcock & Wilcox Co.
2,770,022	11/13/56	Continuous casting of metal	Joseph H. Brennan
2,770,563	11/13/56	Low alloy steel tubing	Acieries de Pompey
2,770,564	11/13/56	Method of quenching metals	Mack Gordon
2,770,871	11/20/56	Filler metal piece for the welding of spheroidal graphite cast iron	The Compagnie de Pont-a-Mousson
2,771,176	11/20/56	Conditioning device for bundles of coiled wire	United States Steel Corp.
2,771,211	11/20/56	Slide cover for converting a box into a feed hopper	United States Steel Corp.
2,771,281	11/20/56	Benzol scrubbing apparatus	Carl Otto
2,771,290	11/20/56	Gas off-take for cupolas	American Radiator & Standard Sanitary Corp.
2,771,341	11/20/56	Method of recovering vanadium values from iron ores	Hoganis-Billesholms Aktiebolag
2,771,354	11/20/56	Concentration of iron ores	National Lead Co.
2,771,637	11/27/56	Production of strip from metal powder	John E. Silvasy
2,771,800	11/27/56	Plug rolling mill	United States Steel Corp.
2,772,006	11/27/56	Cupola stock line indicator	Modern Equipment Co.
2,772,084	11/27/56	Heating furnace for billets	Jones & Laughlin Steel Corp.
2,772,153	11/27/56	Roasting pyrites	Texas Gulf Sulphur Co.
2,772,155	11/27/56	Heat-resisting austenitic steel alloys	Sulzer Freres
2,772,226	11/27/56	Coke oven door	Koppers Co., Inc.

Catenary Furnaces

A 12,000 lbs/hour Fuel-fired Catenary Annealing Furnace for stainless strip used in line with spray quench followed by descaling and pickling baths.

FURNACE CHARACTERISTICS

Inside Dimensions 50'-0" long x 7'-0" wide x 6'-8⅜" high

Fuel Input ..... 1,800,000 BTU/hour

Operating Temperature Range . . 1200 to 2250°F

Stainless Strip . . . . . Cold reduced—annealed in gauges from 0.007" to 0.125"

Stainless Strip . . . . . Hot rolled—annealed in gauges from 0.093" to 0.200"

Three (3) zone proportioning control

Complete control over fuel-air ratio to maintain desired atmosphere in furnace

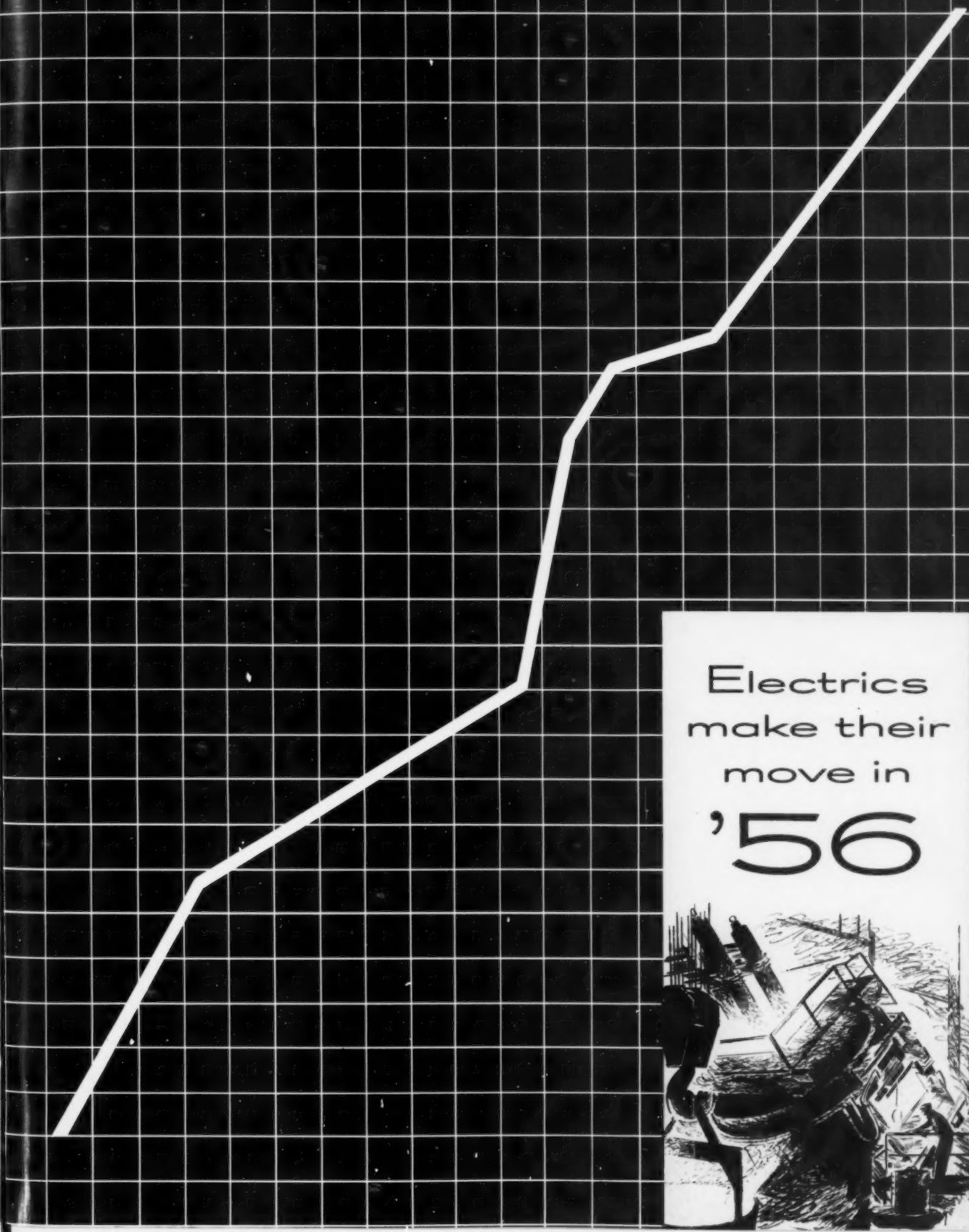
DREVER COMPANY

RED LION RD. & PHILMONT AVE., BETHAYRES, PA.

23

NATIONAL CARBON COMPANY'S

CARBON AND GRAPHITE NEWS



Electrics make their move in '56

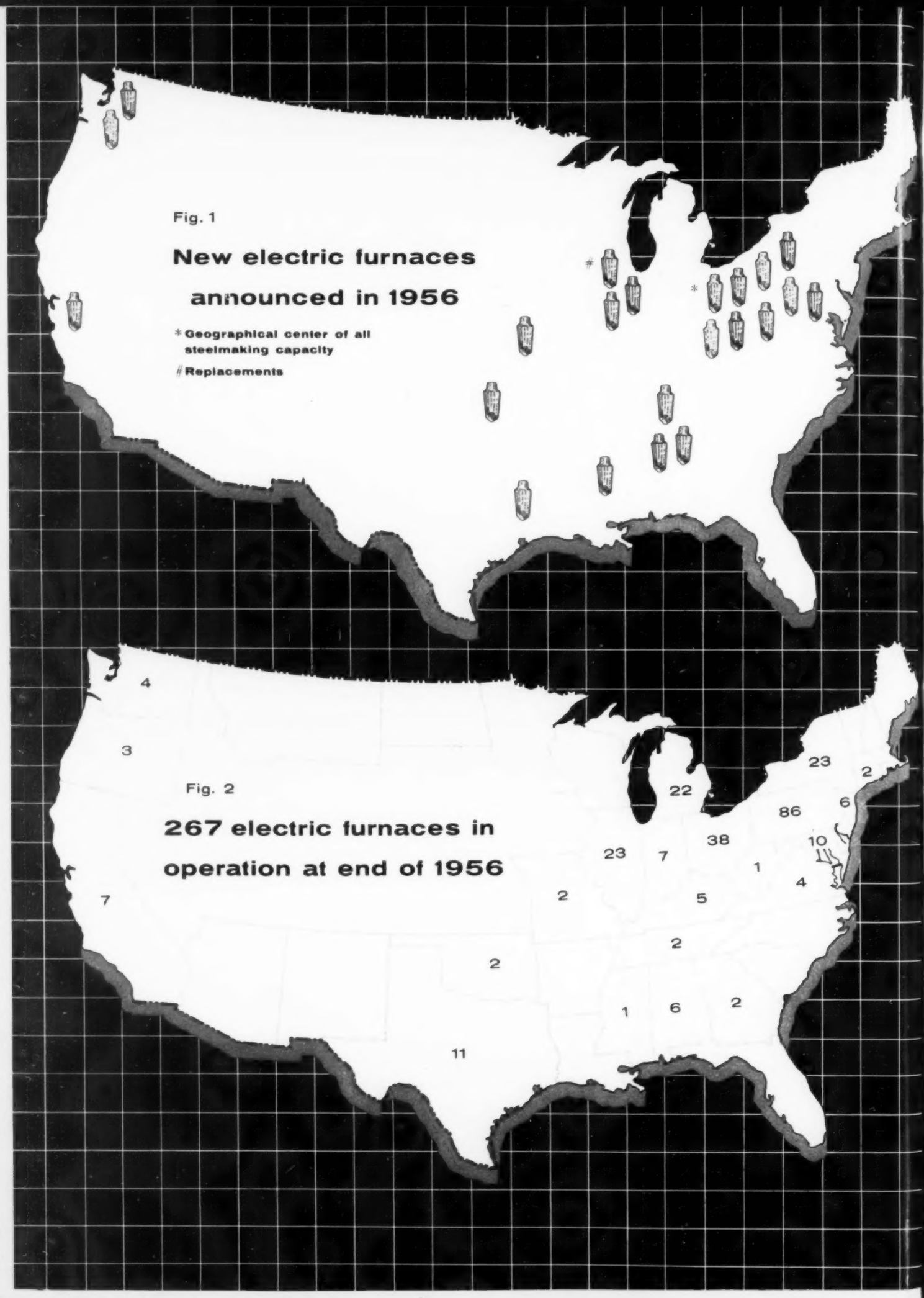


Fig. 1
New electric furnaces announced in 1956
* Geographical center of all steelmaking capacity
# Replacements
Fig. 2
267 electric furnaces in operation at end of 1956
4
3
7
2
2
11
1
6
2
22
23
7
38
5
1
23
2
86
6
10
4

Electrics make their move in '56

Plans for the installation of a record 19 new electric furnaces — with a total capacity of more than 2.5 million tons — were announced by steelmakers during 1956. In addition, replacement of existing furnaces with larger units will add another 372,000 tons, boosting the new electric furnace capacity disclosed during the year over the 2.8 million ton mark. At the end of 1956, there were 267 electric furnaces in operation, with a record installed capacity of 11,501,700 tons. This new high, together with unprecedented expansion plans, made 1956 a really big year for electrics.

Geographic scattering of these new units, which represent more than 25 percent of new steelmaking capacity, is illustrated in *Fig. 1*. The fact that a majority of the new electric furnaces are to be in locations remote from the geographic center of the country's steelmaking capacity speaks well for the inherent characteristics of the electric furnace that make it possible to take advantage of local scrap, power, and market conditions in planning new facilities. *Fig. 2* shows the distribution of the 267 electric furnaces in operation at the end of 1956.

This tremendous surge in electric furnace activity is characteristic of the fabulous growth of this versatile steelmaking tool since the first heat was poured just over 50 years ago. By 1915, total electric furnace steel approximated 80,000 tons, which could be produced today in just one medium-sized furnace. From 1935 to 1955 electric furnace capacity increased 925 percent, as contrasted to a comparable growth of 61 percent for the open hearth.

Plain Carbon Steel Sets Pace

By 1940, electric furnace steel capacity had risen to 1,500,000 tons per year, or about 2.3 percent of total steel capacity. Most of these electrics were confined to the production of alloy steels. Following World War II, the industry was faced with the problem of utilizing electric furnace capacity that had been producing armor plate and other specialty steels required for the war effort. It was at this time that serious consideration was first given to the electric furnace as a producer of plain carbon steel. As shown in *Fig. 3*, the curve of the percentage of carbon steel ingots made in the electric furnace took a sharp swing upward, and has been rising ever since. By 1947, electric furnace production of plain carbon steel caught up with and passed electric furnace alloy steel production. Each year since then the greatest gains have been in plain carbon steel. Some industry observers estimate that by 1975 approximately 30 percent of total carbon steel ingots will be produced by electrics.

As the electric furnace is becoming an increasingly important factor in the production of plain carbon steel, and continues to play a leading role in the production of alloy and stainless steels, it naturally follows that electrics are assuming a more predominant position in the steelmaking industry as a whole. The curves of *Fig. 4* compare electric furnace ingot capacity and total steel ingot capacity in terms of 1940 levels, and illustrate the much more rapid growth of electrics as compared to the total capacity. Although the industry as a whole has followed the characteristic growth curve, electric furnace capacity has obviously passed through both a development and surge phase, and is now evidencing the characteristics of normal, healthy growth. The growth of electric steel capacity as a percentage of total steel capacity is shown graphically in *Fig. 5*.

Technology Fosters Expansion

Along with the increase in the size of the electric furnace industry have come logical technological developments that have played an important part in making this growth possible. The removable roof, higher capacity transformers, and improved regulation systems have been important contributions that have made possible larger and larger units. The original hand-charged three-ton electric furnace has grown into today's top-charged 200-ton giant, with even larger units contemplated. It is likely, some experts predict, that the larger furnaces of the future might well utilize six electrodes in an elliptical shell. Because of the electric furnace's flexibility, in shops where demand charges on electric power are a major consideration, a mixture of large and medium units can be used in order

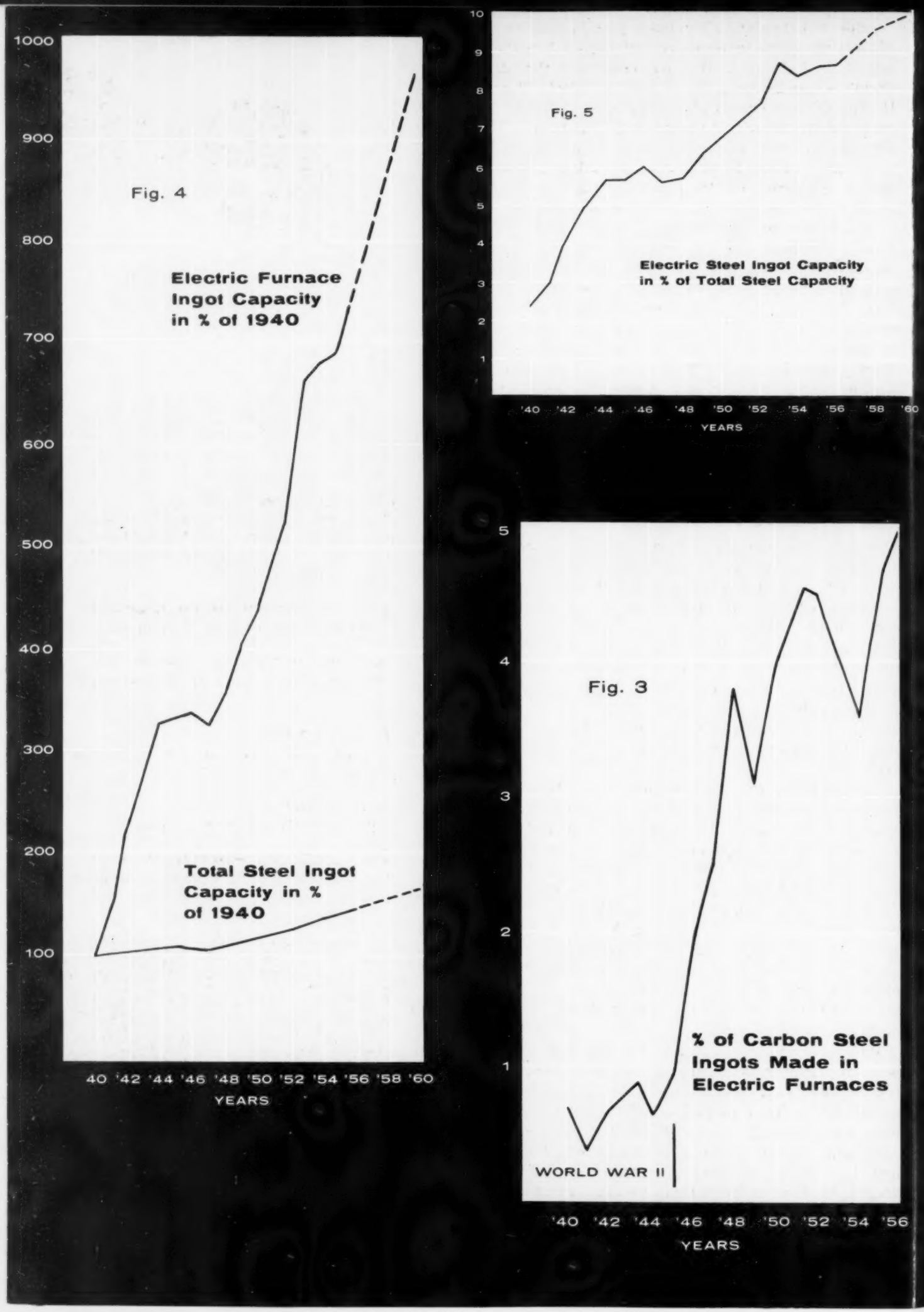


Fig. 4
1000
900
800
700
600
500
400
300
200
100
Electric Furnace Ingot Capacity in % of 1940
Total Steel Ingot Capacity in % of 1940
40 '42 '44 '46 '48 '50 '52 '54 '56 '58 '60
YEARS
Fig. 5
10
9
8
7
6
5
4
3
2
1
Electric Steel Ingot Capacity in % of Total Steel Capacity
'40 '42 '44 '46 '48 '50 '52 '54 '56 '58 '60
YEARS
Fig. 3
5
4
3
2
1
% of Carbon Steel Ingots Made in Electric Furnaces
WORLD WAR II
'40 '42 '44 '46 '48 '50 '52 '54 '56
YEARS

to maintain a high load factor.

Improved regulation has made possible the use of higher powered furnaces, permitting quick melting of the light scrap that has been used almost exclusively in electrics since the end of World War II. The greater energy-absorbing area of lighter scrap allows the use of higher power, and removable roofs permit quick charging, so the developments go together in increasing the efficiency of the electric furnace to the point that plain carbon steel production is competitive with open hearths.

In addition to supplementing open hearths in fully integrated mills as desirable consumers of revert scrap, electric furnaces are almost universally accepted to be the economic answer to non-integrated operations producing plain carbon steels. Some steelmakers have chosen to use electrics and scrap to level out periods of peak and slack production, rather than resort to the heavy capital investment in blast furnaces. Others have found the flexibility offered by electrics to be the answer to their diversification problems, and still others are thinking of duplexing with oxygen converters. No matter how the future of steelmaking is approached, the electric furnace is in the picture.

Charging Developments Affect Future

One of the few deterrents to the unlimited growth of the electric furnace in the United States is the scrap situation. During recent months, domestic scrap prices have actually exceeded the price of pig iron, and consequently increasing attention is being given to hot metal charging of electric furnaces. The desiliconization of hot metal and the production of electric furnace pig iron are developments to be closely watched. A number of means for the direct hydrogen reduction of ore have been developed and publicized, and are not to be discounted.

The evolution of a good hot-metal practice for the electric furnace, and the development of a source of directly-reduced iron (other than blast furnace iron) for charging will open up an almost unlimited future for electric steel. With fuel costs for open hearths estimated up some 25 percent by 1975 (in terms of 1956 dollars) and electric power costs being reduced by increasing the efficiency of generation, the favorable open hearth economics of recent years will disappear. It is significant that electric furnace melting has been employed by the six most recent entrants into the steelmaking industry.

Perhaps every year can't be the big year 1956 was, but authorities visualize a growth in the electric furnace production of carbon steel of approximately 1,000,000 tons a year for the next 20 years, with alloys adding another 6,000,000 tons total. Although new steel-producing processes will also find their places, the electric furnace's flexibility, geographic independence, temperature control, deoxidation ability, start-up and shut-down ease, minimum space and labor requirements, and relatively low capital investment indicate many more "big years" ahead.

Look Ahead—
Look Electric

Gives greatest flexibility—
Makes any steel—any time—from stainless to plain carbon. Handles cold scrap, metallics, hot metal. Starts, stops quickly—gives faster melts.

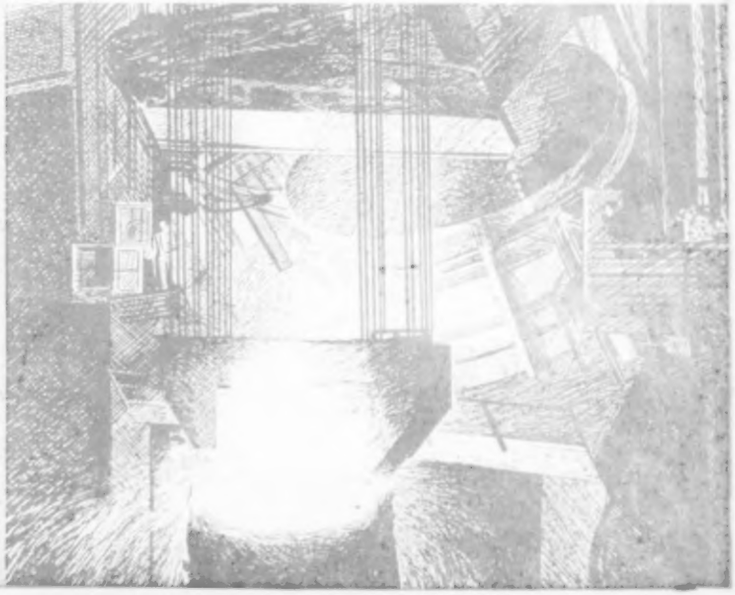
Delivers highest quality product—
Closer temperature control possible.

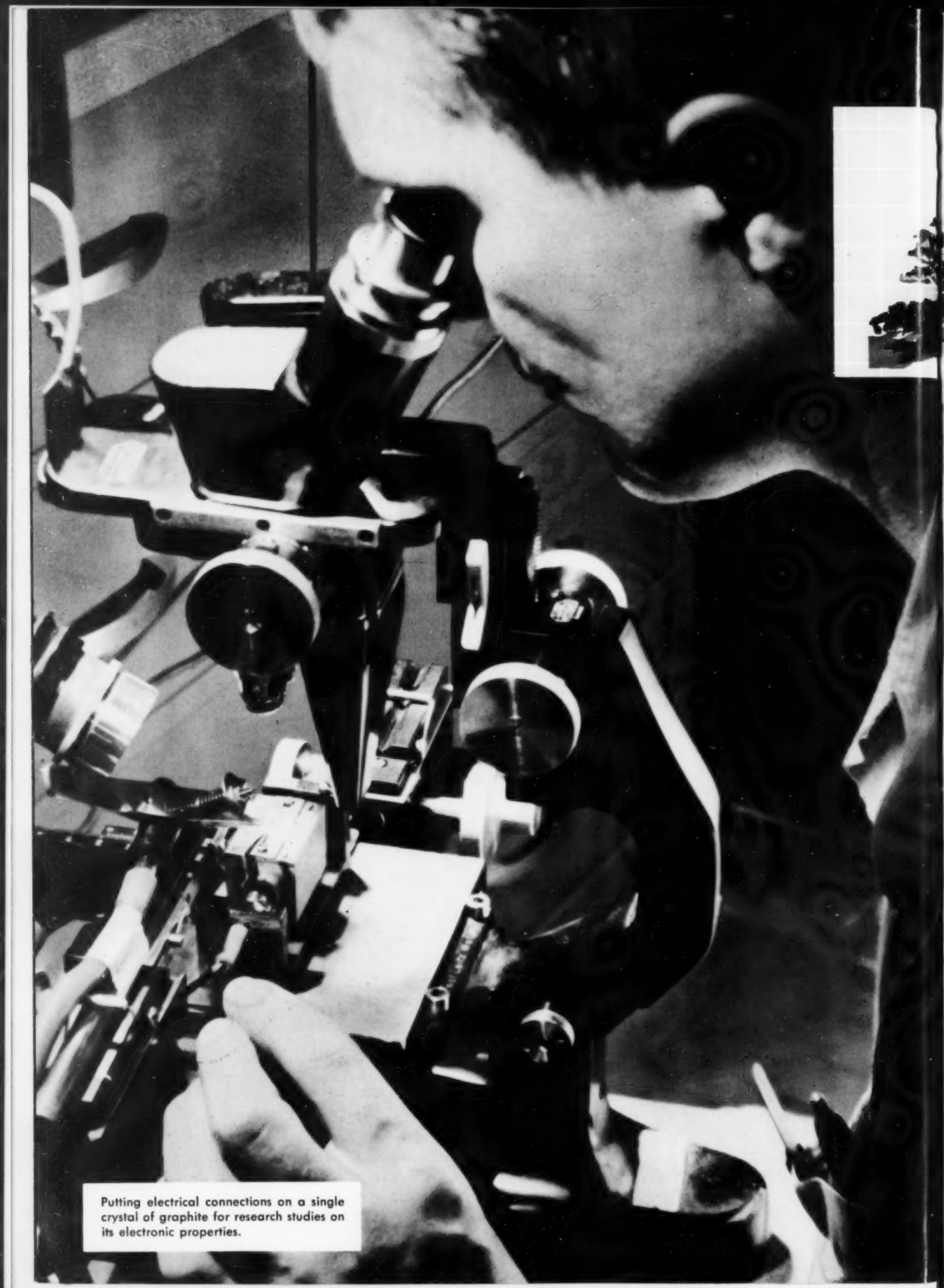
Lowers capital investment—
40% less than equivalent open-hearth capacity.

Saves space—
Savings of 25% and more vs. open hearths producing same tonnage.

Goes up fast—
Capital investment pays off sooner.

Uses clean fuel—electricity—
No combustion products to contaminate melt.





Putting electrical connections on a single crystal of graphite for research studies on its electronic properties.

Working at the outer boundaries of knowledge

RESEARCH AT NATIONAL CARBON'S NEW LABORATORIES, PARMA, OHIO

Albert Einstein once expressed the opinion that the trouble with theoretical physics was its frequent inability to provide quick solutions to urgent practical problems. Long recognizing the validity of this observation, National Carbon Company shuttles its immediate practical problems to its Product Development Laboratories; turns over theoretical and basic research to the highly specialized teams of scientists at its newly dedicated Research Laboratories at Parma, Ohio.

At this ultra-modern, multi-million dollar facility, research combat teams attack fundamental problems in four highly complex, strategic areas — carbon and graphite basic research, high temperature processes, solid state physics (and closely related chemical physics) and electrochemistry. These teams seek the basic concepts from which the answers can subsequently be fashioned to many practical questions on electric furnace electrodes, refractories, nuclear power plants and nuclear armament, high temperature lubricants, electro-winning of metals, the electrochemistry of new battery systems and many other areas of prime importance to industry.

Basic Carbon and Graphite Research

Carbon and graphite electrodes, carbon brick, carbon blast furnace and cupola linings, carbon brushes for motors and generators are all vital tools of the trade well known to the steel industry. To seek new and better forms of carbon for these and countless other existent and future applications is Parma's mission today. The task is formidable when one considers the roadblocks to research thrown up by the peculiarities of the element carbon itself. The traditional techniques for working with such materials as iron and steel or copper and brass are not applicable to carbon for here is a substance which can neither be melted nor cast in molds as can most metals and plastics.

It is not found in nature in usable sizes or shapes, so products of carbon must be manufactured — a process which involves making a suitable mix of finely ground particles and binding agent, molding or extruding the resultant mixture to desired size and shape and then carefully heat treating under precisely controlled conditions for unusually long time cycles.

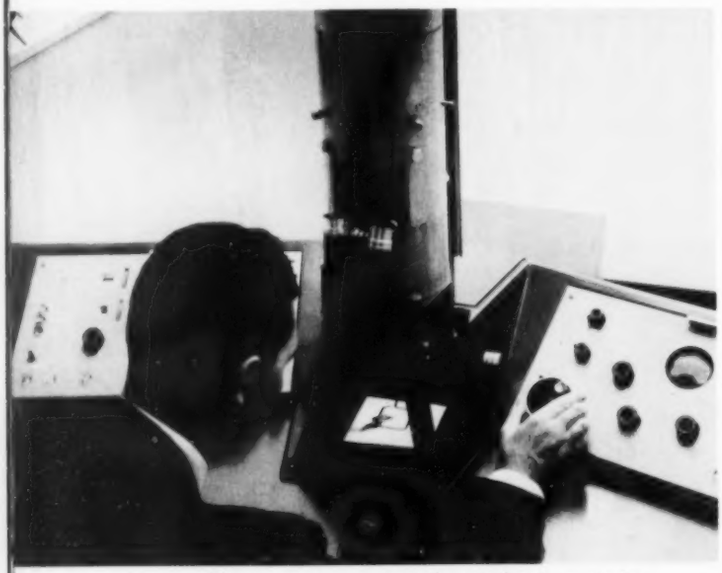
Single Crystals Yield Their Secrets

All carbon and graphite materials basically consist of clusters of many, many small graphite crystals. The great variation in electrical and thermal behavior between what appear to the eye to be similar carbon specimens is explained by the variations in sizes and physical relationships between the tiny graphite crystals within these several carbon specimens.

It is such variations which account for the wide range of thermal conductivities exhibited by various specimens of graphite. One lot can be manufactured with a thermal conductivity five times greater than copper's; another lot with an insulation value greater than that of ordinary building brick — a conductivity range factor of more than 1000 to 1!

In order better to study carbon's properties and, more importantly, to enable the tailor-making of a particular carbon with a predictable set of properties for a specified application, it is necessary to isolate and investigate single graphite crystals. Until recently, this has proven a most

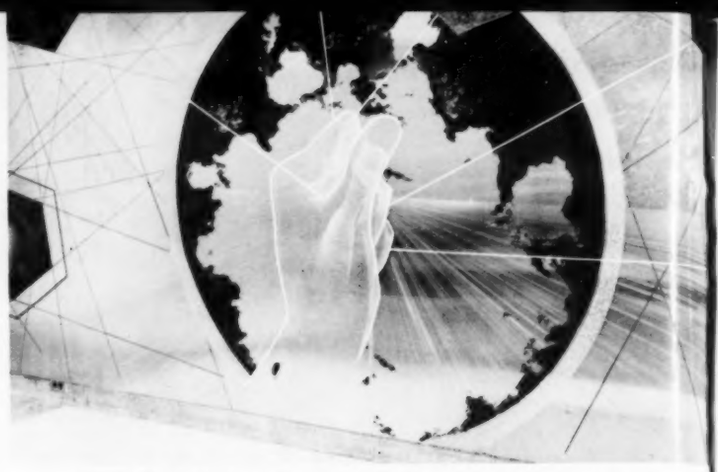
frustrating area to explore because impurities in the crystals defied eradication and thus distorted experimental data. But now National Carbon scientists have perfected new techniques for purification which remove chemical contaminants from the crystals and, at the same time, banish imperfections and weaknesses from the crystalline structure itself. Result: fused graphite crystals approaching the ideal for purity and structural perfection — a "break-through" of major significance along the roadway leading to fundamental quantitative data on graphite's behavior.



Electron microscope probes carbon's mysteries.

High Temperature Refractories

Another significant field of inquiry having great potential importance for industry is the Parma Laboratories' investigation of high temperature phenomena with emphasis on the synthesis of a new, broad class of super-hard materials to perform satisfactorily at temperatures over 4,000°F! Typical is titanium diboride, the hardest man-made material having no counterpart in nature. Successfully made at Parma by company-developed fusing methods, titanium diboride slices through fine knife steel easily, is suitable for cutting stainless, holds much promise for rocket motor nozzles and turbine blades. And there is titanium carbide, extremely hard and corrosion resistant. And cerium monosulphide destined for a major role in producing zirconium and titanium, metals vital to nuclear power plants and jet engines. These are but a few of the high temperature materials of tomorrow being perfected as a result of basic research in National Carbon Laboratories today.



Symbol of Modern Research—Emblazoned in Epoxy Resins and Stainless Steel . . . The Story of Man's Endless Groping for Knowledge. (From Impressive New Mural Executed by Buell Mullin for National Carbon Research Laboratories)

Beyond The Outer Boundaries Of Knowledge

Where does this elaborate, far-flung program lead? Perhaps the most revealing tip-off comes from observing the scientists involved, watching their restless zeal as they pursue the answers to questions which, until recent years, could not even have been asked. It soon becomes apparent that this huge research endeavor, despite its complexities, is directed toward a clearly perceivable goal — the extension of the frontiers of pure science, breaking through the outer boundaries of today's knowledge.

If you would like to know more about the important work being done at Parma, send for our free booklet "Research"—Just address: Advertising Department, National Carbon Company, 30 East 42nd Street, New York City 17, New York

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY

A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
IN CANADA: National Carbon Company
Division of Union Carbide Canada Limited, Toronto

UCC

LITHO IN U.S.A.

Copyright 1957, Union Carbide and Carbon Corporation

New Automatic Precipitator Control by

WESTERN PRECIPITATION

offers many vital advantages...

1 LONG LIFE

This new control has indefinite life expectancy under all types of operating conditions. There are no tubes to replace, no high speed relays, counters, or timers to maintain. All circuitry consists of rugged "static" devices that have unusually long life!

2 RELIABILITY

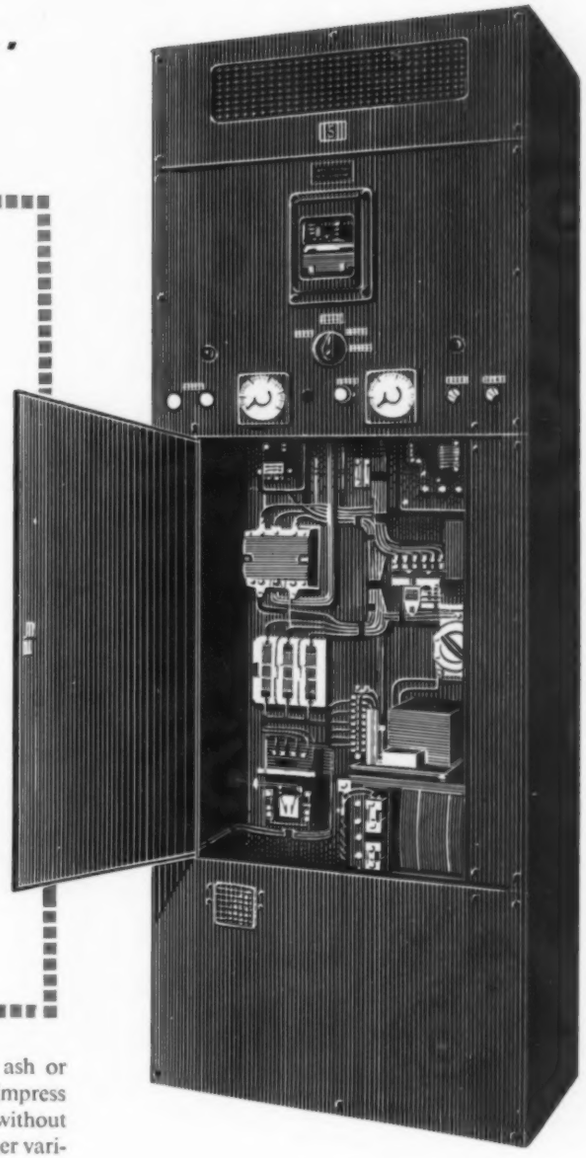
Optimum Precipitator power input is maintained regardless of operating conditions. The sensing control is simple, positive, accurate—and automatically evaluates the spark "Power Value" (intensity and frequency)—not just frequency or intensity alone.

3 STABILITY

Under short circuit, open circuit or other varying conditions, this control is completely stable and inherently trouble-free!

4 MODEST COST

Modest initial cost coupled with negligible maintenance assure optimum operating efficiency (therefore lower operating costs) throughout many years of continuous service.



WHEN using a Cottrell Precipitator for collecting dust, fume, fly ash or other suspensions from industrial gases, it is essential at all times to impress on the high voltage system the highest possible voltage and current without "flashover". Depending upon gas conditions, dust loading and other variable factors, the optimum voltage and current requirements vary widely from one minute to the next. Therefore, the vital importance of a simple, trouble-free and highly sensitive Precipitator Control is self-evident.

This new Western Precipitation Automatic Precipitator Control—*a product of the organization that has consistently led in the application of Cottrell Precipitators for industrial gas cleaning*—combines vital advantages found in no other competitive equipment. Our nearest representative will be glad to supply complete details. Or write direct!

Why not modernize your present out-dated Precipitator installation? The Western Precipitation Automatic Precipitator Control can be installed on any Cottrell unit. For further information contact our nearest office!

Western Precipitation Corporation

Designers and Manufacturers of Equipment for Collection of Suspended Material from Gases ..and Equipment for the Process Industries

Main Offices: **1067 WEST NINTH STREET, LOS ANGELES 54, CALIFORNIA**

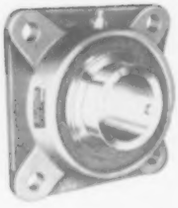
Chrysler Building, New York 17 • 1 North La Salle Street Building, Chicago 2 • Oliver Building, Pittsburgh 22 • 3252 Peachtree Road N. E., Atlanta 5 • Hobart Building, San Francisco 4

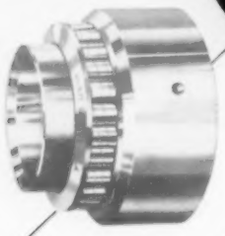
Precipitation Company of Canada Ltd., Dominion Square Building, Montreal

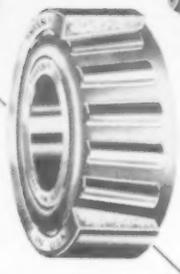
Representatives in all principal cities

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Reverse-Jet Filters
HOLO-FLITE Processors

953 phone calls







Every business day, an average of 953 customers phone Berry Bearing Company and order a wide variety of bearings, bearing specialties, and transmission appliances of all types and sizes.

To handle that volume--21 incoming lines are needed! And, 2 expert switchboard operators are kept busy taking care of the large number of calls. In addition, because incoming calls have top priority--20 extra phones with separate outside lines are used for outgoing calls only. Thus, the incoming calls are handled fast. They always get speedy service, the first step in maintaining Berry Bearing Company's traditional--IMMEDIATE DELIVERY.

If, like thousands of others, you appreciate real service--simply reach for your phone and dial DAnube 6-6800--and you'll get it. You can also depend on immediate delivery, too, because you're no more than 5 miles and 27 minutes away from one of Berry's 6 strategic Chicagoland locations.

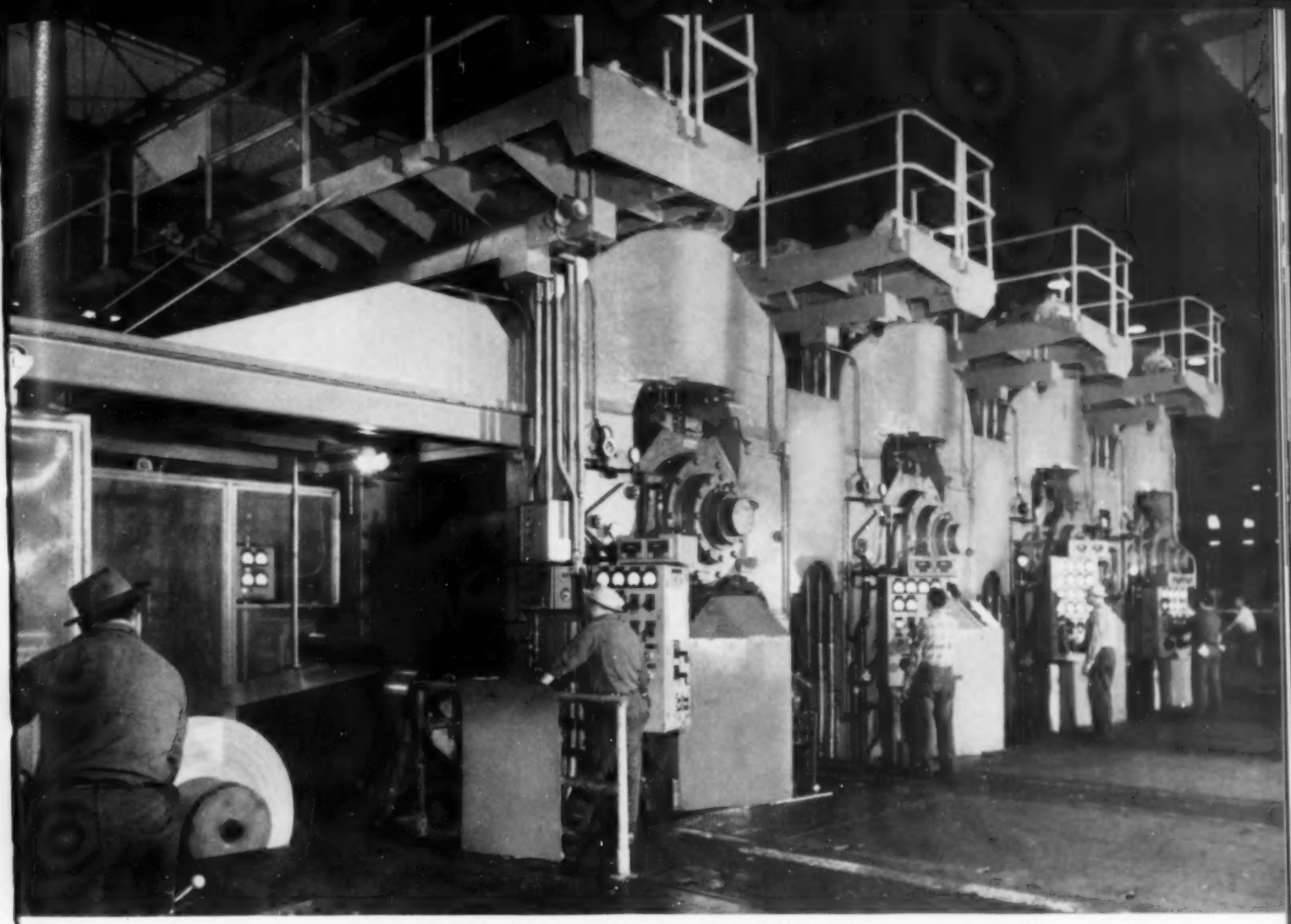
MEMBER AFBDA ANTI-FRICTION BEARING DISTRIBUTORS ASSOCIATION

BERRY BEARING COMPANY

All phones--DAnube 6-6800

2633 S. Michigan Ave. • • • • Chicago 16, Illinois

SOUTHWEST	OAK PARK	SKOKIE	ROCKFORD	HAMMOND	GARY
6923 W. Archer Ave.	327 Madison St.	4438 Oakton St.	710 Broadway	4828 Calumet Ave.	716 E. 5th Ave.
LUdlow 5-4400	EUclid 6-1700	ORchard 4-6600	Phone: 2-5561	WEstmore 1-3010	TUrner 5-7501



This 66" four-stand tandem cold strip mill at Pittsburgh Steel operates at speeds up to 3190 fpm maximum, has 17,700-hp total drive motor capacity.

Higher speed...more on-gauge strip

with Westinghouse Magamp* regulators on coordinated mill drive systems

In March, 1954, the first tandem cold reduction strip mill controlled entirely by Westinghouse Magamp magnetic amplifier regulators was installed at the Pittsburgh Steel Company, Allenport, Pennsylvania. This control's performance since then has resulted in higher permissible operating speeds and more on-gauge strip. Practically no adjustment or maintenance has been required on the mill stand and reel regulating equipment.

Two other four-stand tandem mills with individual generator power supply and all Magamp control are operating successfully, and equipment for four additional mills is being manufactured or installed.

*Trade-Mark

See how Westinghouse coordinated drive systems are Magamp controlled for greater productivity

YOU CAN BE SURE...IF IT'S

Westinghouse

Precise Magamp power control yields . . .

More on-gauge strip at 6000 fpm and beyond

More on-gauge strip during acceleration, deceleration and rated speed rolling are yours with Westinghouse Magamp regulators . . . even with the trend toward greater power application. Results are fewer waste ends, increased productivity.

A Magamp regulator system delivers optimum over-all mill performance because it properly regulates and improves the response characteristics of mill and reel motors and power supply generators.

Magamp's high amplification and extremely short response time assure accurate generator voltage control. Operation from 400 cycles gives fast response and inherent stability without complex or critically adjusted damping circuits. Here's how the system works:

DRIVE ARRANGEMENT—Working rolls in mill stands one and two are driven together through pinion stands. Upper and lower rolls in stands three, four and five are driven separately through offsetting speed-up gears, the 6000-hp #5 drive consisting of two 3000-hp, double-armature motors. Winding reel motor is 1500-hp, triple armature. Each stand and reel drive is supplied from separate generators, on two motor-generator sets with duplicate 12,000-hp synchronous driving motors.

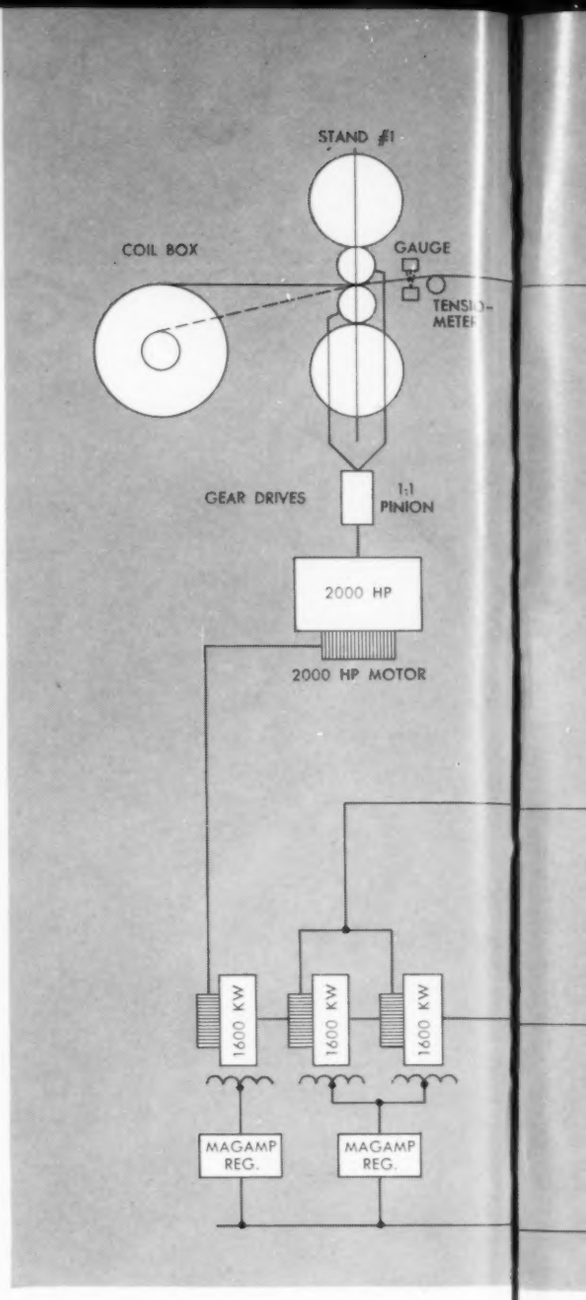
MAGAMP REGULATOR CONTROL—Generator(s) for each stand and reel power supply is controlled by a Magamp voltage regulator, operating on 400-cycle, three-phase supply from an alternator set.

AUTOMATIC GAUGE CONTROL—Strip thickness gauge at stand one controls stand one screwdown to minimize variations in starting hot strip and to feed uniform strip to rest of mill. Gauge at stand five controls stand five motor speed, and tension between stands four and five to maintain constant gauge of finished strip.

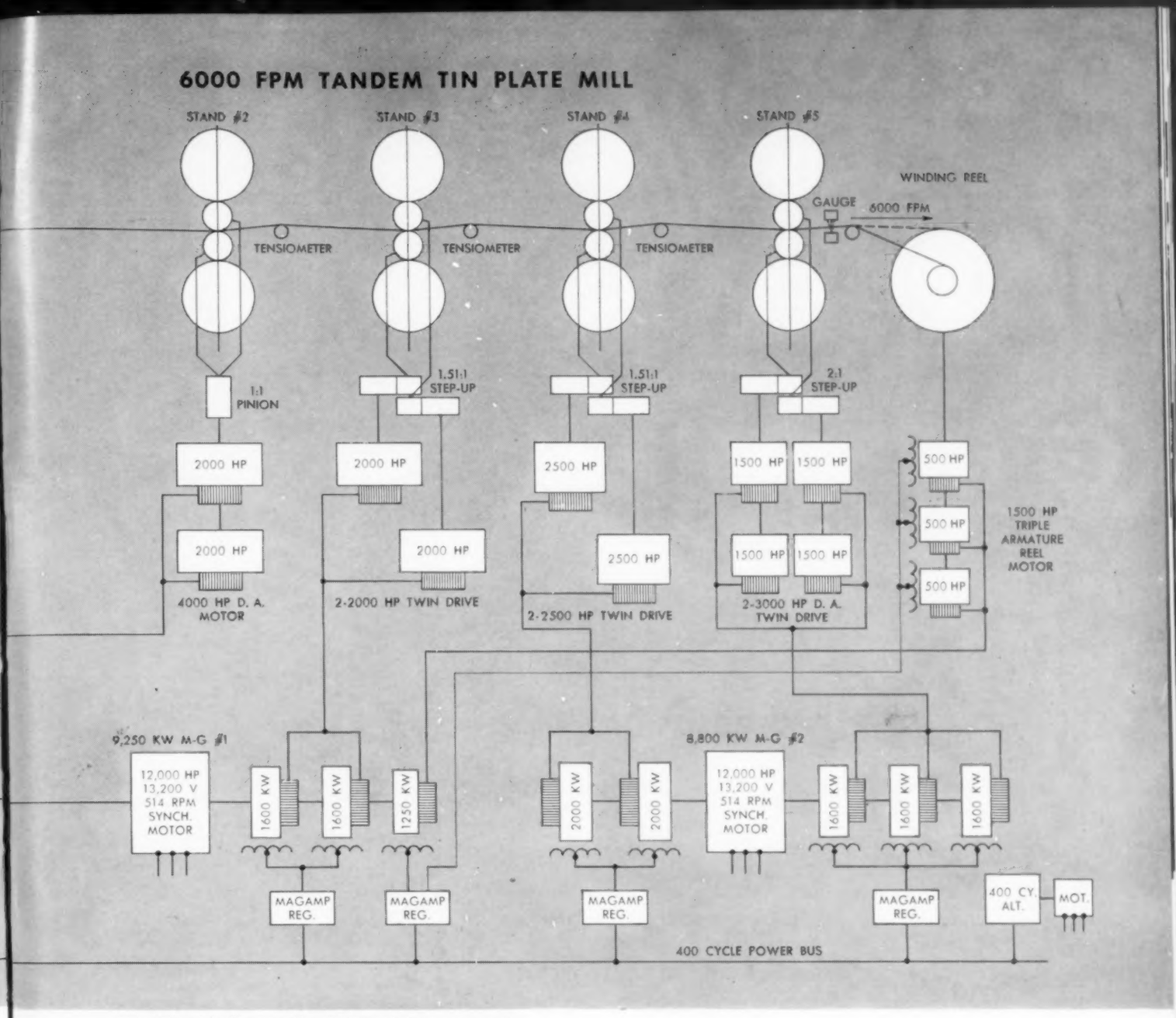
TENSIOMETERS—Units between stands indicate total tension and difference in tension between two edges of the strip.

YOU CAN BE SURE...IF IT'S

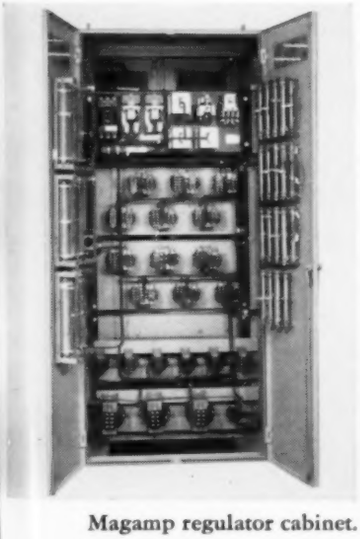
Westinghouse



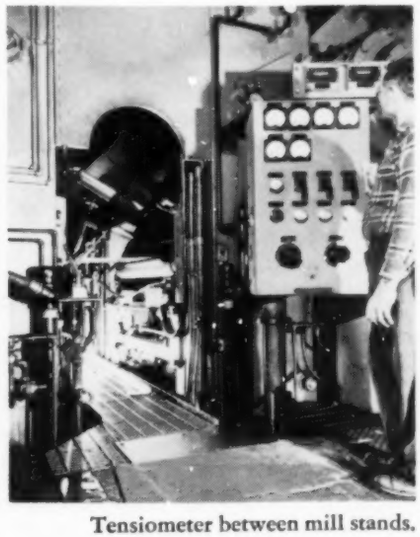
Motor room for 66" tandem cold strip mill.



A 48"-wide five-stand mill like this is now under construction for the Wheeling Steel Corporation. It will have 22,500-hp total drive capacity to produce tin plate and heavier strip at speeds up to 6050 fpm.



Magamp regulator cabinet.



Tensiometer between mill stands.

Progressive users of Magamp regulator control on tandem cold strip mills

PLANT	YEAR	STANDS AND WIDTH	DELIVERY FPM	TOTAL HP
Pittsburgh Steel Co. Allenport, Pa.	1954	4—66"	1595/3190	17,700
Alan-Wood Steel Co. Conshohocken, Pa.	1954	4—32"	1100/2293	6150
Empire Steel Corp. Mansfield, Ohio	1955	4—52"	747/1868	8100
Usinor Montataire, France	1956	4—66"	1375/3630	19,450
Nonferrous—Ohio	1956	4—32"	850/2075	4400
Steel Mill—Ohio	1957	3—80"	747/1670	13,000
Wheeling Steel Corp. Yorkville, Ohio	1957	5—48"	2750/6050	22,500

Westinghouse Exclusive!

Thermalastic® insulation excels in punishing steel mill duty

Twenty percent greater dielectric strength, ten times greater voltage endurance, 30 times greater tensile strength . . . that's Thermalastic, an amazing insulation available exclusively from Westinghouse.

Thermalastic shrugs off moisture, high voltage and dirt . . . helps Westinghouse motors and motor-generator sets better withstand severe steel mill operating conditions.

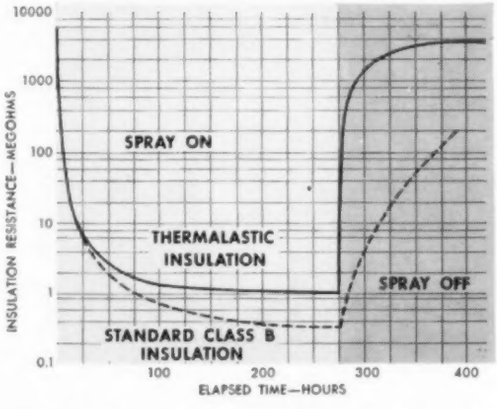
A chemically stable, highly moisture-resistant impregnating resin is used in Thermalastic. This, plus a high degree of fill achieved in the impregnating process, gives Thermalastic extraordinary properties that extend its life in hard service.

Remember, too, Westinghouse switchgear, control centers, ventilation equipment, and gearing are excellent working partners for your Westinghouse coordinated mill drive systems.

From planning to design, installation and start-up . . . Westinghouse is at your service. An experienced Westinghouse team will accept unit responsibility, and work with your engineering staff and consulting engineers in setting up your tandem mill drive.

Contact your Westinghouse sales office for further details. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. MP-3046

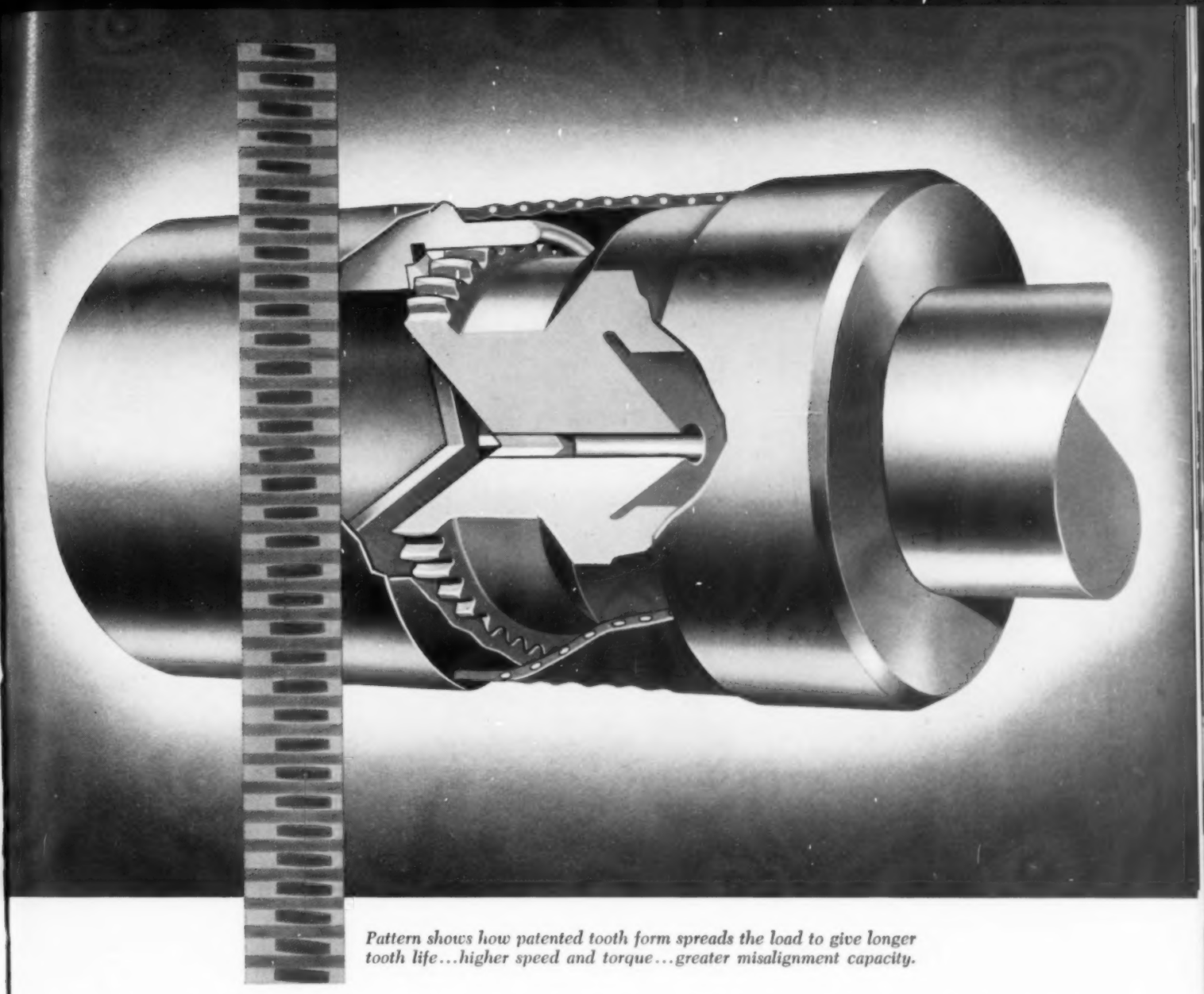
Thermalastic-insulated Westinghouse motor-generator sets (top photo) for 66" four-stand tandem cold strip mill.



Results of typical laboratory spray test demonstrate superior moisture resistance of Thermalastic compared to regular insulation.

YOU CAN BE SURE... IF IT'S

Westinghouse



Pattern shows how patented tooth form spreads the load to give longer tooth life...higher speed and torque...greater misalignment capacity.

Proof that Amerigear-Bliss couplings last longer

Many installations of the Amerigear spindle coupling have operated continuously without tooth failure for four years.

The secret of the long-lasting teeth of the Amerigear-Bliss spindle is their patented fully-crowned form. This eliminates tooth end and tip loading and permits greater angular or lateral misalignment; this results in constant velocity, minimum wear and minimum power loss. The crowned flank maintains the load on the central portion of a greater number of teeth, making higher torque ratings possible, and holding backlash to a minimum.

To sum up, these couplings provide *vastly longer tooth life...higher torque...higher speeds...and higher misalignment capacity.*

E. W. Bliss Company's Rolling Mill Division has acquired all rights to the manufacture and sale for use in rolling mills of the famous Amerigear gear type spindle coupling.

For complete information, write us today.

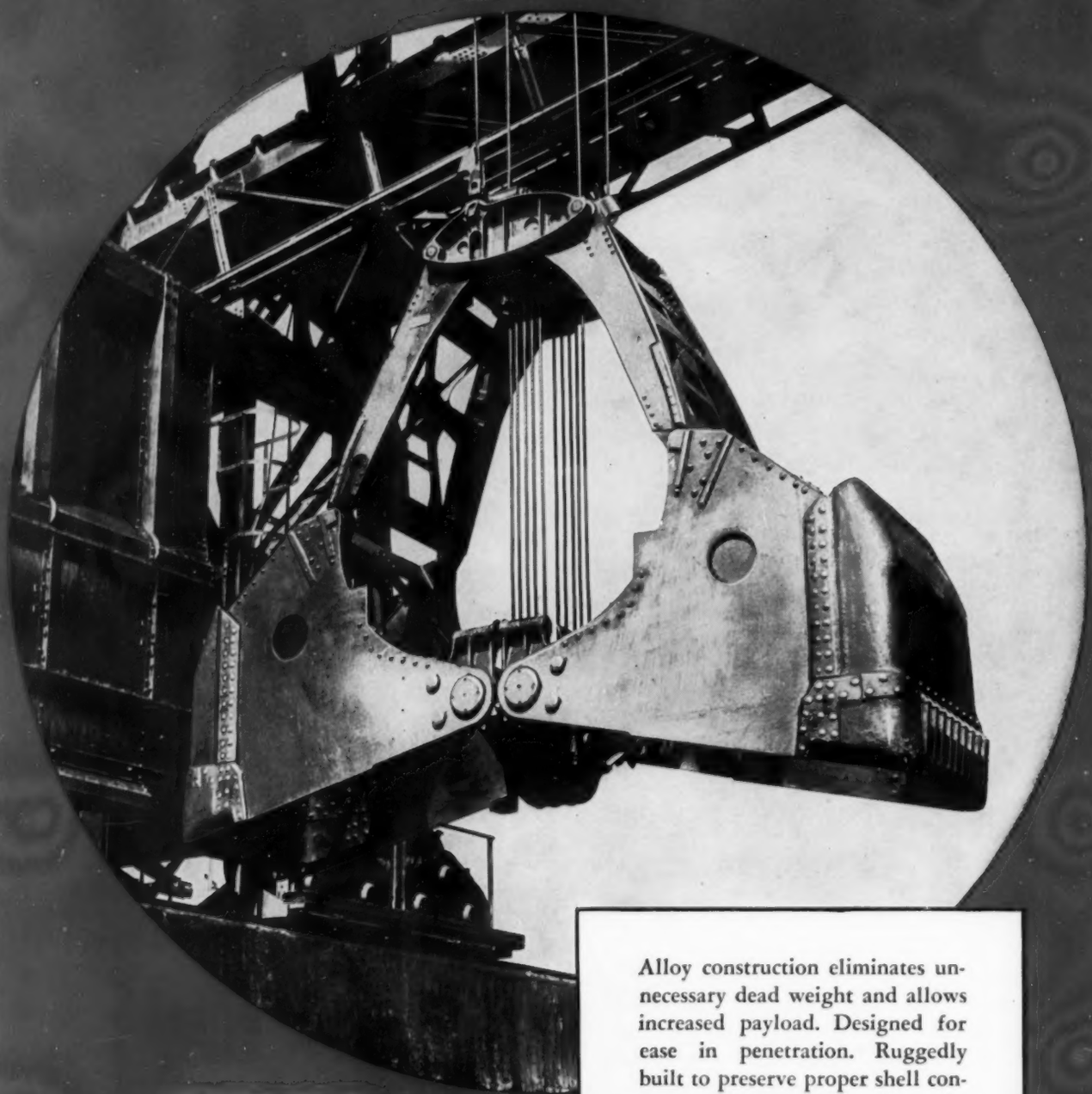
100 years of making metal work for mankind

BLISS
SINCE 1857 ®

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio
Executive Offices: Canton, Ohio

PRESSES • ROLLING MILLS • MILL ROLLS • CAN MACHINERY • DIE SETS • ORDNANCE

MEAD-MORRISON Ore Buckets



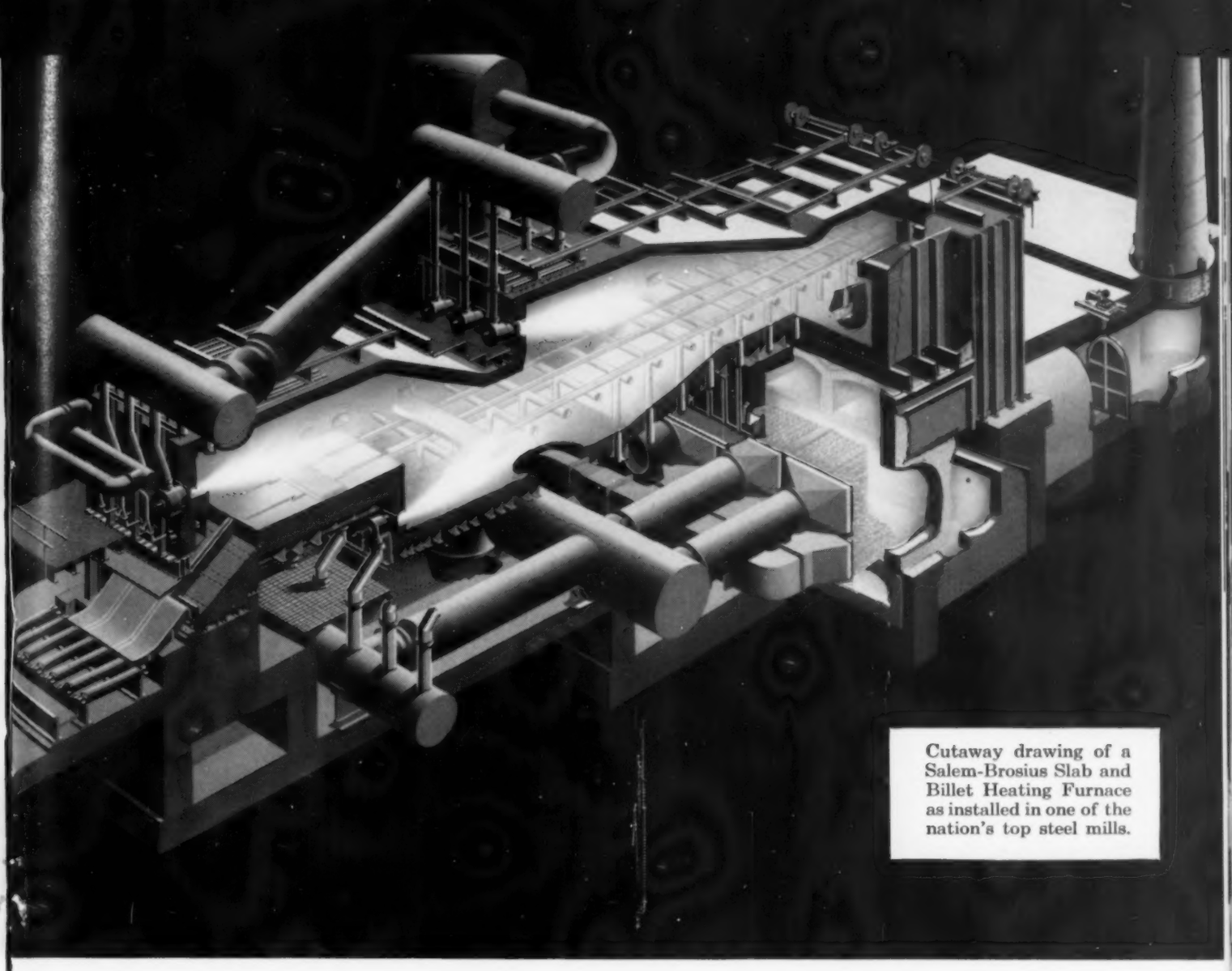
Alloy construction eliminates unnecessary dead weight and allows increased payload. Designed for ease in penetration. Ruggedly built to preserve proper shell contour, maintain correct alignment of bottom head and shell and withstand operating abuse.
Designs to operate at ends of lines and bight of line in a range of sizes. Also clean-up grabs.

Write for full information.

MEAD-MORRISON

Division of
McKIERNAN-TERRY CORPORATION
Manufacturing Engineers • Harrison, N. J.

Also builders of coal and ore bridges, bulk material unloaders, pile hammers, and specially designed machinery



Cutaway drawing of a Salem-Brosius Slab and Billet Heating Furnace as installed in one of the nation's top steel mills.

In this Salem-Brosius furnace better steel products are born

All over the country, steel producers are turning to Salem-Brosius Pusher-Type Slab and Billet Heaters, because they have come to know that these furnaces will produce maximum tonnages of evenly heated, accurately temperatured steel at the lowest fuel consumption rate. The triple-fired furnace shown above features accurately controlled heating and soaking zones, heavy construction, recuperators for fuel economy, dual gas-oil fuel system, low maintenance cost, and many other advantages. These assure positive, automatic control of furnace output and heating quality.

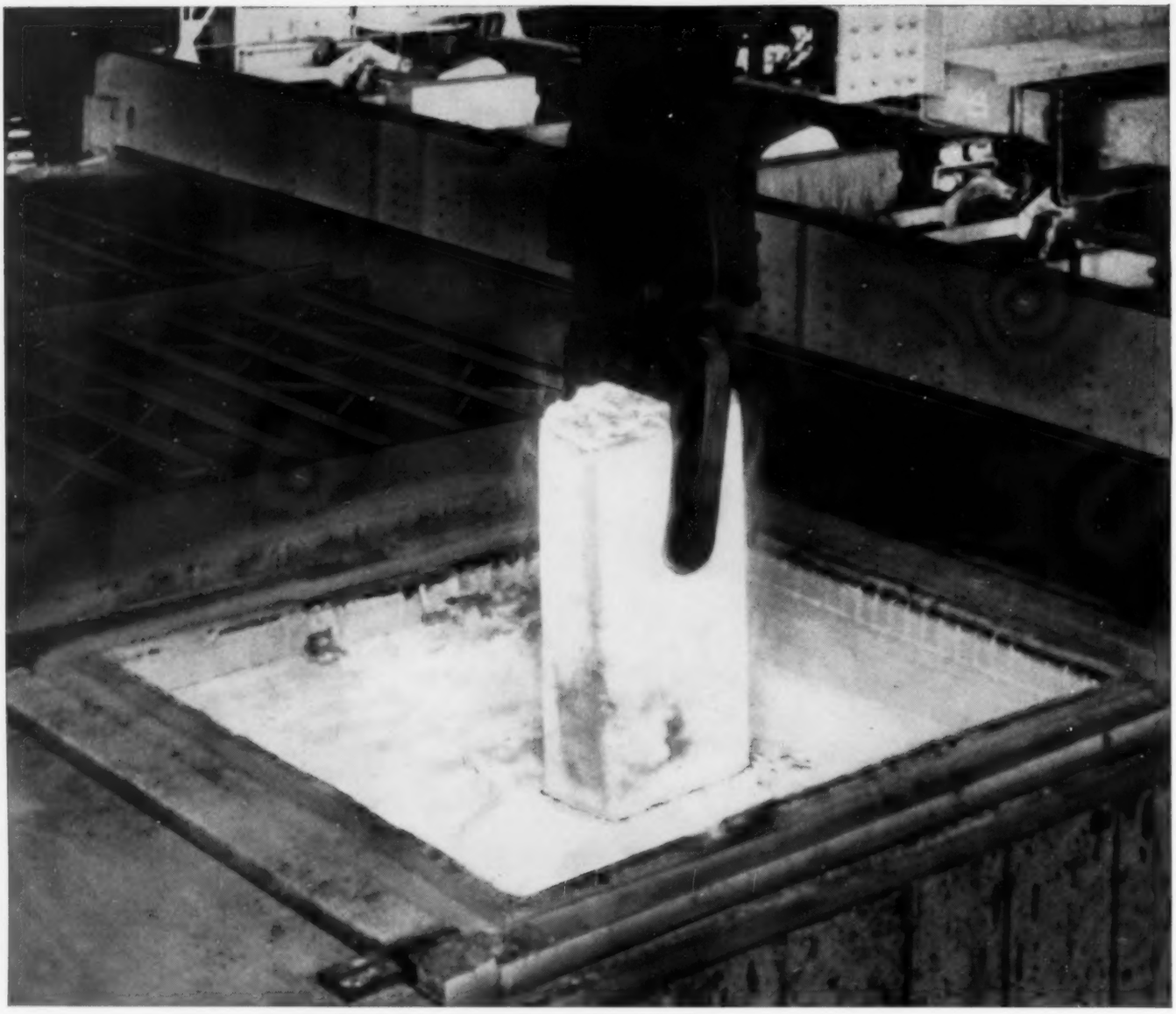
And the efficiency, economy, ease-of-operation, and trouble-free service this furnace affords are typical of all the furnaces Salem-Brosius builds. Whether you require this or any other heating or heat treating furnace, Salem-Brosius offers equipment designed, engineered, and built not merely as a furnace but as a heating machine. You can purchase these furnaces as complete installations—equipped with all controls, piping and wiring—ready to operate. Write to us.

SALEM-BROSIUS, INC.

CARNEGIE, PENNSYLVANIA

In Canada: Salem Engineering Limited • 1525 Bloor Street West, Toronto 9, Ontario

SPECIAL MECHANICAL EQUIPMENT • INDUSTRIAL HEATING FURNACES • MATERIALS HANDLING EQUIPMENT



Hagan soaking pit controls
FAST AND EASY INSTALLATION

Hagan systems on the 15 soaking pits installed as a part of Pittsburgh Steel's modernization program include combustion and pit pressure controls. These pits normally burn a mixture of coke oven and blast furnace gas, held to 200 Btu's. This comparatively low Btu content promotes good pit circulation and even heating during the soaking phase.

Oil is available as an alternate fuel, and the Hagan system is so arranged that when oil is fired, the oil flow transmitter impresses a low differential pneumatic signal (same range as gas flow differential) on the fuel/air ratio control and on the fuel/air meter.

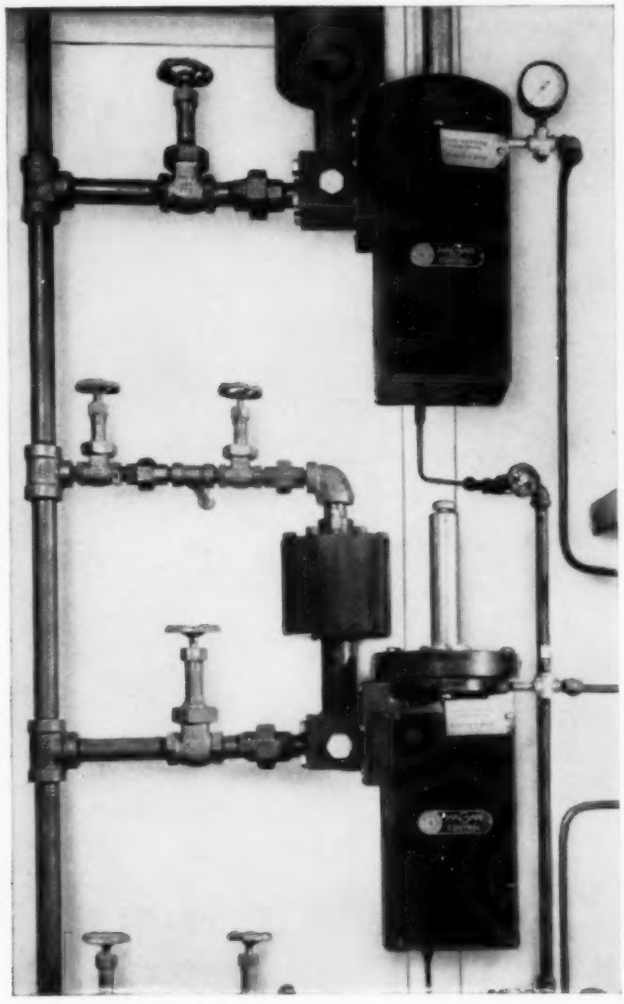
The gas mixing station employs Hagan pressure and ratio controllers to maintain mixed gas header pressure by admitting the two gases in correct proportion.

These systems were put into operation quickly and easily, and plant personnel have found that they stay in calibration and require minimum maintenance.

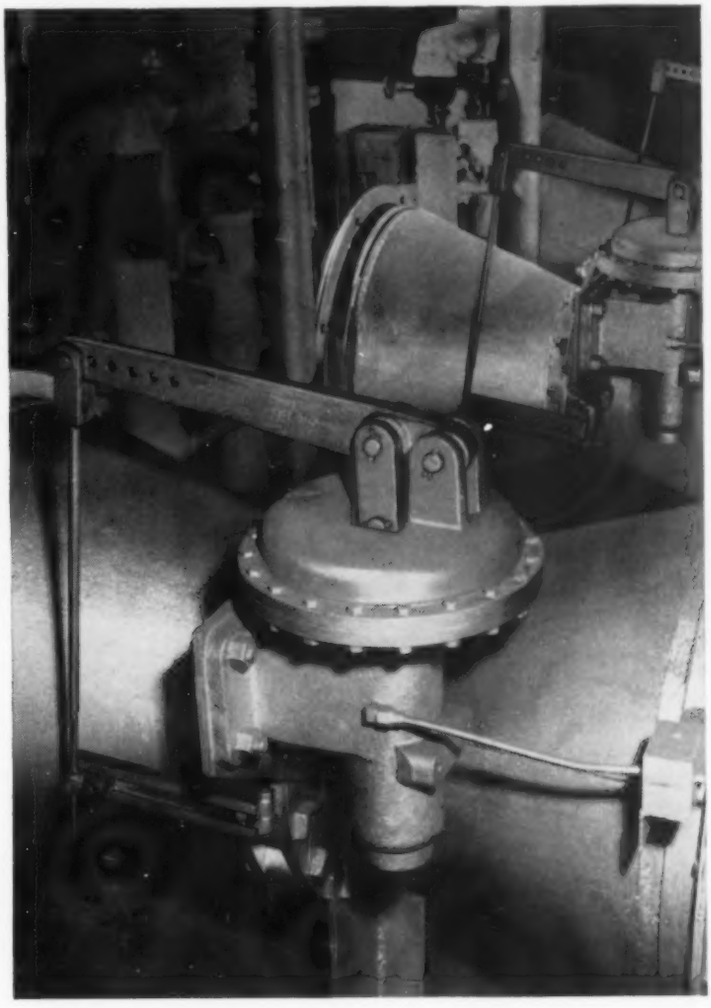
Hagan control systems are also being installed on the enlarged open hearths at Pittsburgh Steel. Fuel/air ratio, furnace pressure control and automatic reversal are among the Hagan automatic control systems to be used on these furnaces.

Hagan systems for soaking pits, blast furnaces, open hearth and heat treating furnaces have established a reputation for accuracy, dependability and minimum maintenance. A Hagan engineer will be glad to discuss metallurgical furnace controls in relation to your particular requirements. A letter or phone call to the address below will receive prompt attention.

Hagan Low-Head Transmitters measure oil flow by means of a sharp edge orifice plate. They develop a low head pneumatic signal which is linear with the differential produced by the oil flow. This signal is then transmitted to the fuel/air ratio control. The Hagan Low-Head transmitter is fast and maintains a high degree of accuracy.

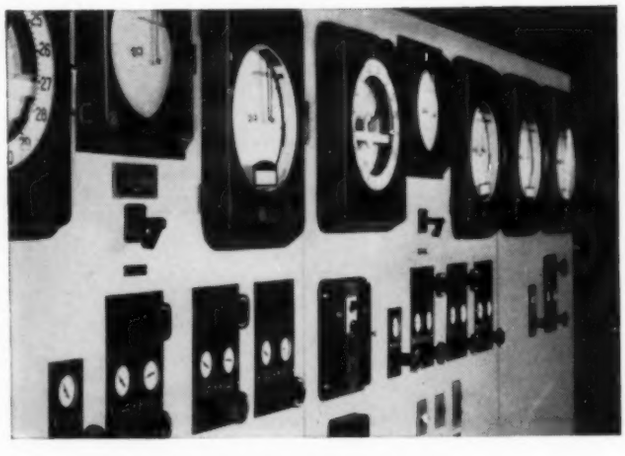


Hagan Diaphragm Operators position low friction dampers on the combustion air inlet fans. These operators provide full modulation, and are extremely fast and accurate. Repeatability is excellent, assuring accurate following of signals from fuel/air ratio control. The Hagan Diaphragm Operator is suited for any low friction positioning application where accuracy and speed are needed.



at Pittsburgh Steel

...MINIMUM MAINTENANCE



Control Panel shows Hagan Ring Balance meters and Hagan Panel Relays. The Ring Balance meters record fuel/air ratio and pit pressure. Hagan Ring Balance meters are versatile, accurate and dependable instruments. They are calibrated by the dead weight system without disconnecting the meter from the line.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA

DIVISIONS: CALGON COMPANY • HALL LABORATORIES

Do you worry about power distribution problems

AT 3:00 A. M.?

If you have a power distribution system problem — either in an old building or in that new one you're planning — here's one way you can stop losing sleep over it. Just use Rockbestos A.V.C. (asbestos, varnished-cambric insulated) Interlocked Armored Cable. It will help you cut costs and at the same time assure you dependable service. Here's why:

- Rockbestos A.V.C. Interlocked Armored Cable gives you more current capacity than cable in conduit or other armored cable. Single conductors are standard N.E.C. Type AVA power cables.
- You save important dollars by eliminating the need for costly conduit or ducts.
- It's easily installed on racks or hangers beneath the ceiling or next to walls.
- It can be installed up, down or around walls, beams or posts.
- It cuts installation time and permits quick, easy repairs.

Get all the details on Rockbestos A.V.C. Interlocked Armored Cable — Write now for catalog which gives complete specifications and application data.

ROCKBESTOS PRODUCTS CORPORATION

NEW HAVEN 4, CONNECTICUT | NEW YORK, CLEVELAND, DETROIT, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, NEW ORLEANS, OAKLAND, SEATTLE

ROCKBESTOS

A. V. C. Interlocked Armored Cable

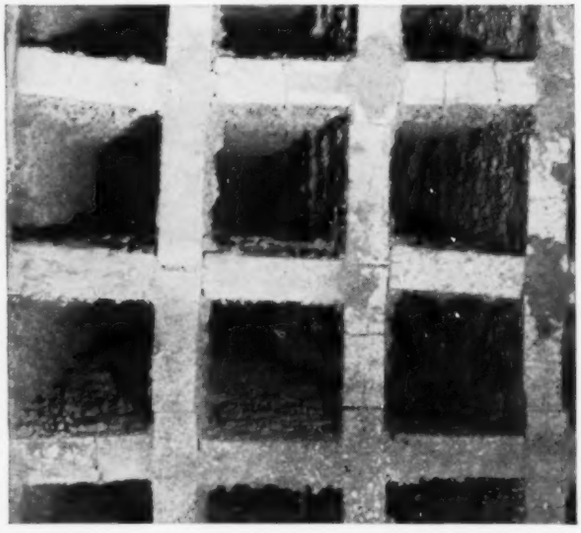
For New Buildings, Expanding Existing Circuits, Relocating Old Circuits

HARBISON-WALKER

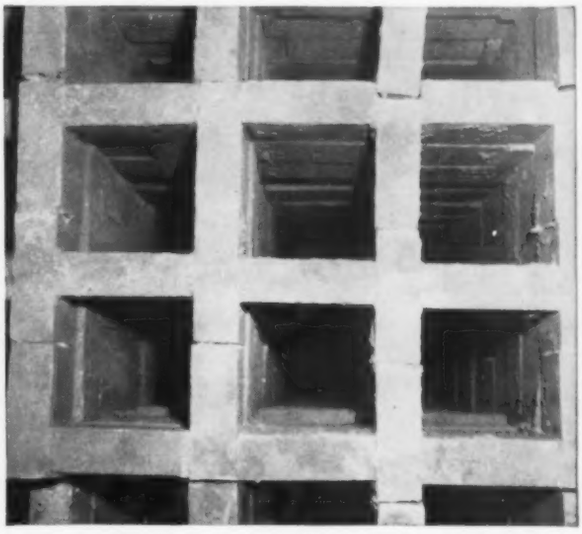
FORSTERITE L

BASIC CHECKERS

provide unusual advantages for open hearth steel furnaces



After two campaigns—378 heats—Forsterite L Open Hearth Checkers appeared as shown above. The friable character of the slight dust build-up is apparent.



Ready to go back into service. Cleaning is quickly and easily accomplished because Forsterite L Checkers resist slagging, spalling and clogging.

With the rapidly increasing use of basic brick checkers for open hearth steel furnaces, many of the various kinds have been in service for careful comparisons. Among the various classes of basic brick used in this application, FORSTERITE L, the magnesium-silicate refractory, shows unusual merit.

Important benefits which contribute to the good economy in the use of FORSTERITE L checkers are briefly enumerated.

1 Increased durability under the most severe operating conditions

FORSTERITE L checkers do not shrink or subside in soaking heats and higher preheat temperatures of the air are feasible. They are highly resistant to slagging and withstand the temperature changes involved without spalling. Because of the excellent stability of mineral composition under the prevailing regenerator conditions, FORSTERITE L brick do not permanently increase in volume nor become weak and friable.

2 Checker cleaning decreased

Due to its chemical composition, iron oxides and basic slag carry-over, do not readily react with FORSTERITE L. These basic fluxes do not wet the FORSTERITE L brick which remain clean and free from excessive clogging. The necessity of cleaning FORSTERITE L checkers used for all or part of the setting is greatly decreased.

3 Greater heat capacity

The inherent properties of the mineral forsterite account for the higher heat capacity of FORSTERITE L brand, than that of alumina-silica refractories. The heat capacity of a checker setting of a given size thus is greatly increased.

4 High efficiency maintained

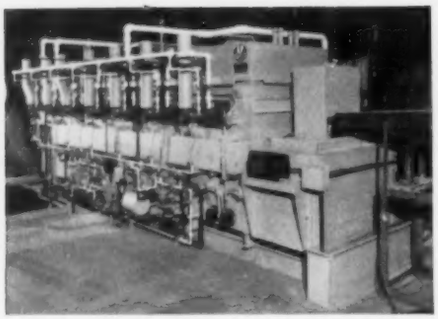
FORSTERITE L checkers retain their normal texture and are less readily glazed than are various other kinds of basic, high alumina and alumina-silica refractories. High heat absorption is not reduced by increased reflection resulting from glazing.

HARBISON-WALKER REFRACTORIES COMPANY

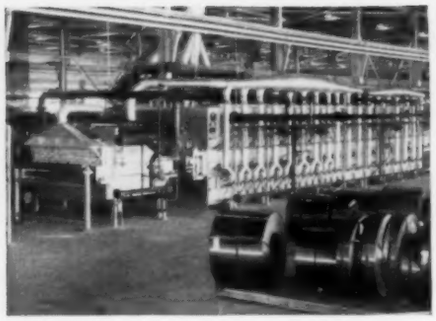
AND SUBSIDIARIES

World's Most Complete Refractories Service

GENERAL OFFICES: PITTSBURGH 22, PENNSYLVANIA



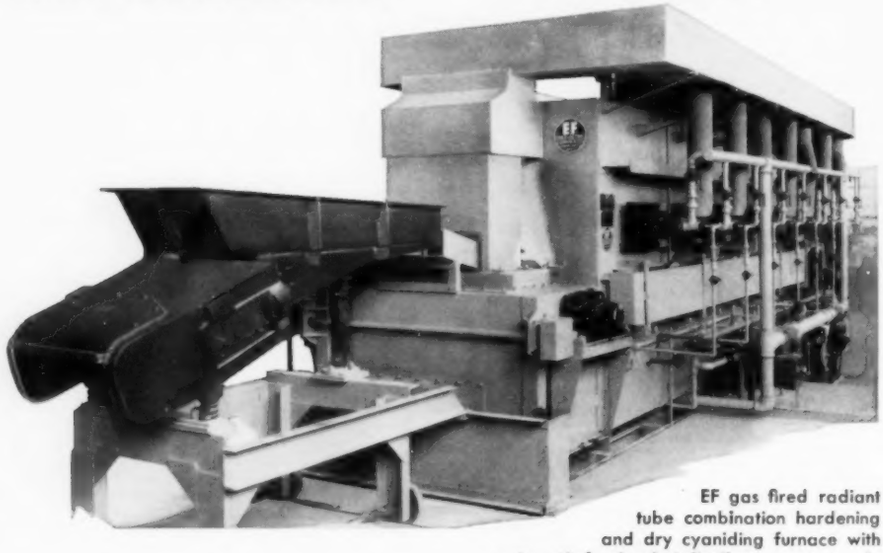
Carbonitriding, carbon correction, carburizing, scale free hardening and other processes are handled uniformly, economically and continuously in EF furnaces.



EF gas fired unit—bright anneals wide or narrow strip in single or multiple strands. Other continuous and batch types for ferrous or non-ferrous, including stainless.

Tubing, strip, rod and wire in coils, strands or on reels are being uniformly processed in hundreds of EF continuous and batch type furnace installations.

EF PRODUCTION FURNACES



EF gas fired radiant tube combination hardening and dry cyaniding furnace with automatic feeder that distributes parts evenly on conveyor; and a dual oil, water quench.

give you the jump on competition

Charging end of EF special atmosphere bulkhead pusher furnace; bright anneals copper and copperweld wire and clean anneals brass wire. Capacity 4000 lbs. per hour.

● Correctly designed to meet your specific requirements;—built in our own plant under exacting controls and supervision, and incorporating the most advanced heating practices, EF furnaces assure users the utmost efficiency and economy of operation.

The day after day, and month after month dependability of operation fully up to rated output; and ease of control, make EF furnaces the logical choice for installation in continuous "automated" processing lines, giving users the many advantages of this modern manufacturing technique.

Unvarying uniformity of finished product simplifies and reduces the costs of subsequent forming, fabricating and finishing operations, further reducing the cost of the completed product and improving your competitive advantage.

Whether yours is a problem of annealing, normalizing, carburizing, brazing, coating, nitriding, sintering, aging, or any other treatment of ferrous or non-ferrous products, You'll find . . .

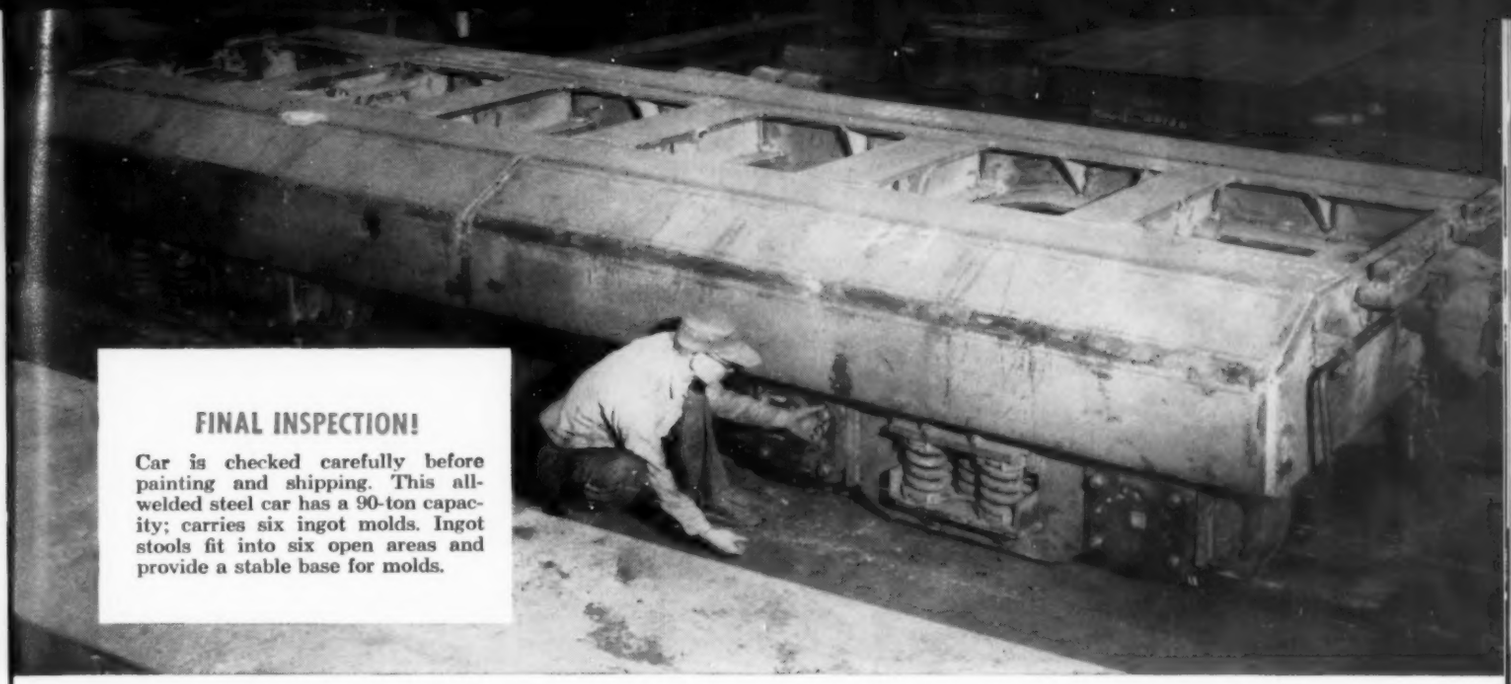
it pays to submit your production furnace problems to experienced EF engineers.

THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

Salem - Ohio

Canadian Associates • CANEFCO LIMITED • Toronto 1, Canada



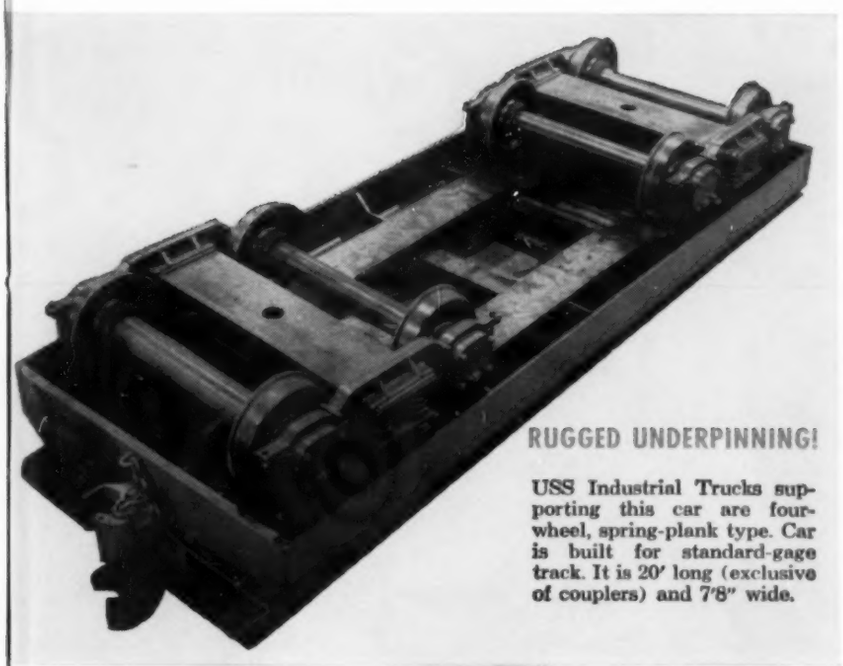
FINAL INSPECTION!

Car is checked carefully before painting and shipping. This all-welded steel car has a 90-ton capacity; carries six ingot molds. Ingot stools fit into six open areas and provide a stable base for molds.

INGOT MOLD CARS

USS-DESIGNED

to your specifications



RUGGED UNDERPINNING!

USS Industrial Trucks supporting this car are four-wheel, spring-plank type. Car is built for standard-gage track. It is 20′ long (exclusive of couplers) and 7′8″ wide.

NAME THE KIND OF CAR YOU NEED in your steel plant, and chances are that United States Steel can supply it. Our engineers specialize in designing and building industrial cars to meet users' requirements exactly.

The ingot mold car pictured here is a good example of our custom-made cars. This all-welded steel car has a capacity of 90 tons. The deck plate is provided with six open areas to accommodate the ingot mold stools.

USS-Designed Ingot Mold Cars can be built in a wide variety of types and sizes—from cars weighing 8,000 pounds, designed to carry two small ingots . . . to cars weighing more than 66,000 pounds, capable of carrying loads up to 250 tons.

Cars can be built for either narrow or standard-gage track. Trucks have four or eight wheels. Anti-friction bearings are either inboard or outboard. Cars can even be equipped with flexible trucks that permit movement over irregular track.

For more information, send for a free copy of our 32-page illustrated booklet—"USS Custom Designed Cars." And remember, you can call in our engineers for consultation at any time.

USS INDUSTRIAL CARS

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

United States Steel Corporation
525 William Penn Place, Room 2801
Pittsburgh 30, Pennsylvania

Please send me a free copy of your 32-page booklet, "USS Custom Designed Cars."

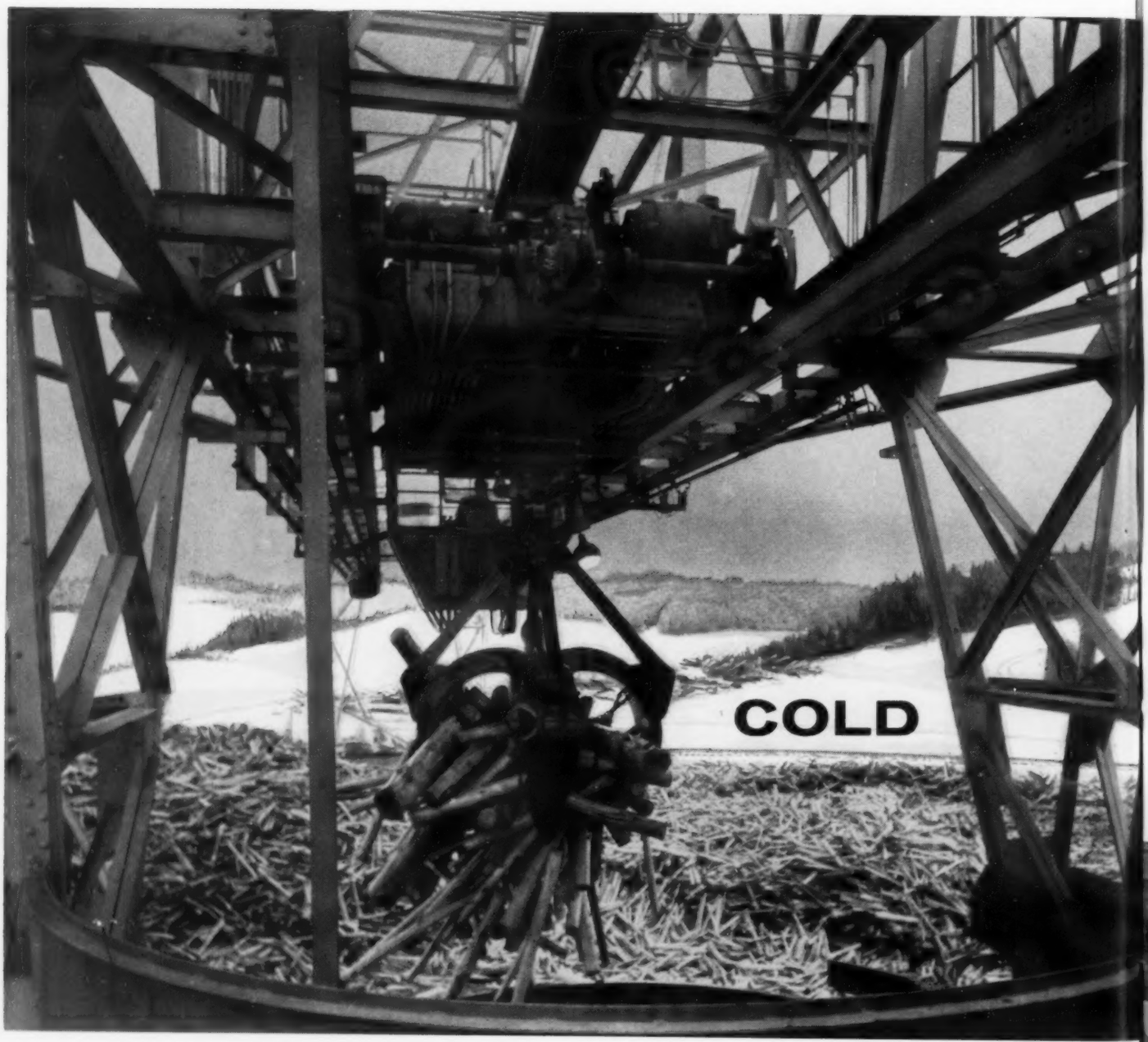
Name .....

Company .....

Address .....

City ..... State .....

New! Multi-purpose



Gulfcrown stands up to cold. It pumps easily in coldest weather at temperatures of 0°F. and below.

GULFCROWN Grease

does the work of many greases —withstands heat, cold, water

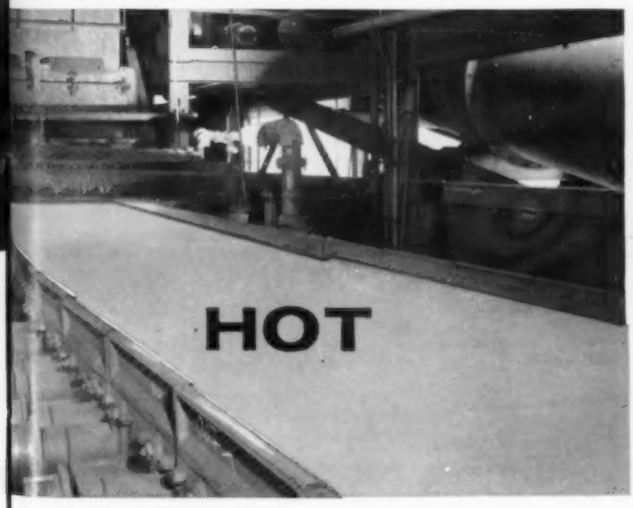
It's a fact—you can use Gulfcrown practically anywhere! On plain or antifriction bearings. In paper mills, textile mills, steel mills, power plants. Outside or inside. You name it, chances are Gulfcrown will lubricate it—but good! Operating conditions can be hot, cold or wet . . . this tough all-purpose grease does its job regardless.

You can see how one multi-purpose grease that does the work of many is a big money-saver. It reduces inventory, cuts lubricating costs and prevents application errors. Check the saving yourself—test Gulfcrown. Ask your Gulf sales engineer or write for free literature.

GULF

GULF OIL CORPORATION
1822 Gulf Building, Pittsburgh 30, Pa.

Gulfcrown resists heat. It won't get thin, won't run out of bearings even at 250°F.



Gulfcrown sheds water—won't wash away. That's why it's a good rust preventive, too, under the dampest conditions such as this wet end of a paper machine.

MAKE SURE YOUR NEXT BULK MATERIALS HANDLING UNLOADER HAS THESE IMPORTANT DRAVO FEATURES:

- Liberal Use of Welded Components
- Double Web Truss System with Beam Sections
- Positive Wind Protection with Dravo Rail Clamps
- Fully Equalized Loading on Truck Wheels
- Use of Unit Construction for Mechanical Elements
- TROLLEY ACCIDENT PREVENTION WITH DRAVO HYDRAULIC BUFFERS

These six-foot stroke hydraulic buffers, installed on end of ore bridge span, provide safe stop for a 120-ton man trolley traveling at 900 feet per minute.

DRAVO Unloaders...

Hydraulic Buffers Stop Trolley Safely at any Speed

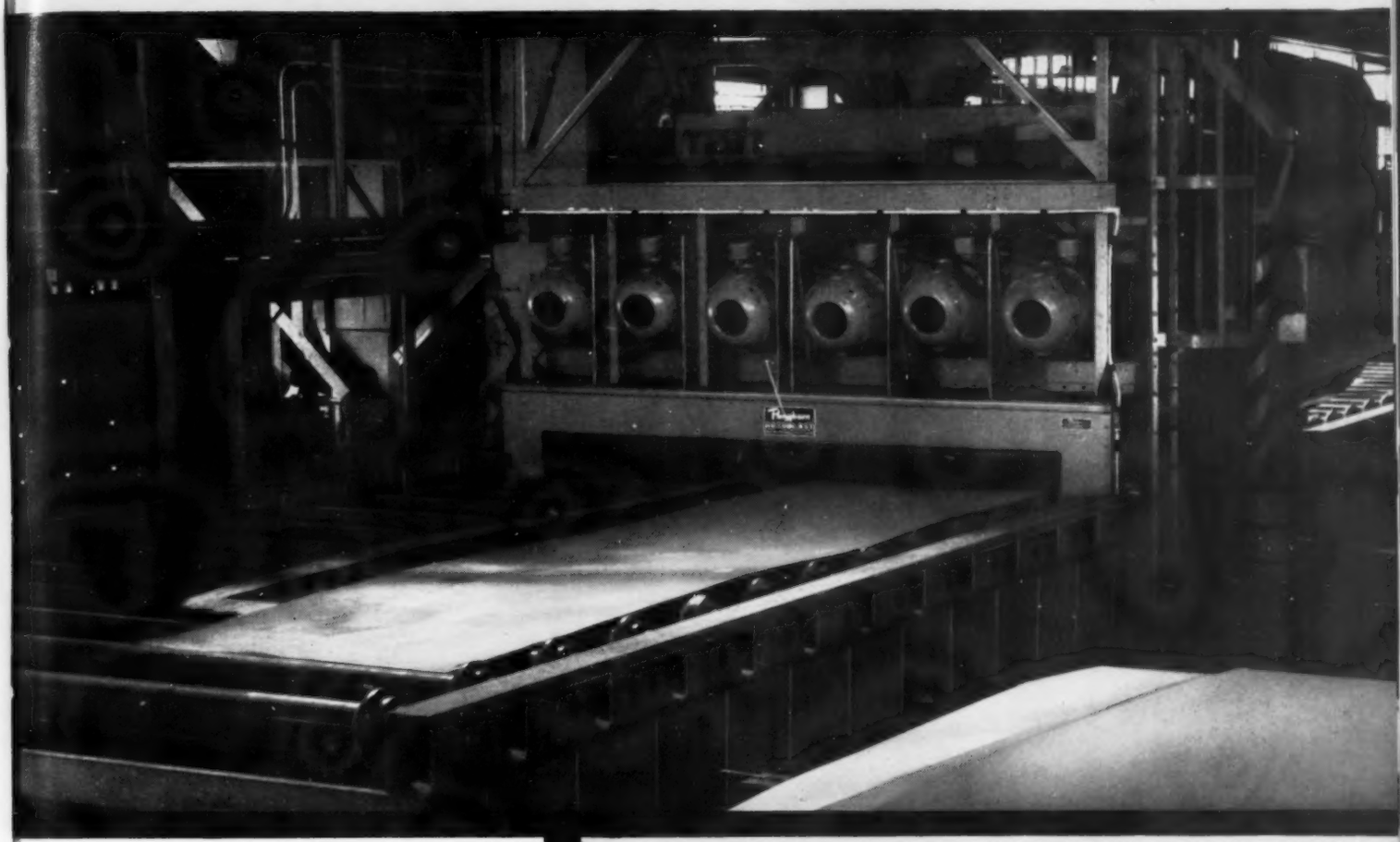
The use of hydraulic buffers is one example of how Dravo builds efficiency and safety into unloaders. Operators work more efficiently when safety is assured by smooth, hydraulic-buffered stops. In fact, every Dravo unloader is individually designed to handle its specific job not only safely, but also dependably and economically. Such performance is made possible by bringing together the customer's operating knowledge and the experience of Dravo's research, design and construction men.

This method has resulted in high efficiency unloaders and other bulk materials handling equipment that produce because they are tailored to fit the job. Dravo engineering features, built into every structure, provide for low maintenance and operating costs. For complete information on Dravo unloaders and ore bridges, write to Dravo Corporation, Pittsburgh 25, Pa.

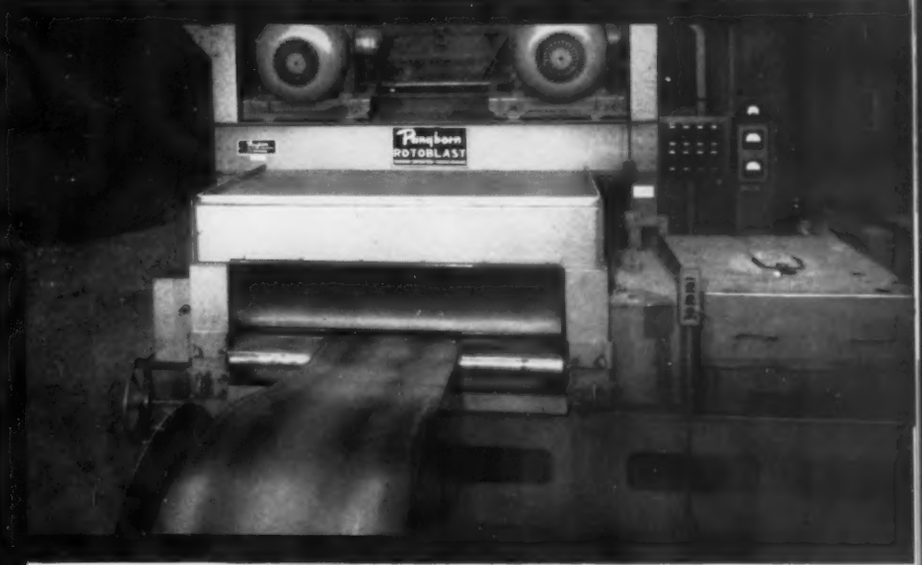
DRAVO
CORPORATION

Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation

Descale steel sheets, plates, coils



at *less than half the cost*



No more scale breaking or pickling! No more acid disposal problems! Pangborn Rotoblast Descaling Machines descale steel sheets, plates and coils, and they operate at big savings over pickling costs!

How? They work quickly. They clean thoroughly. They're a one-man operation. Unlike acid baths, they can be located near your production, cutting handling costs. And they save floor space, require much less room than vats. Available in a variety of models, Pangborn Rotoblast Descaling Machines handle steel sheets, plates and coils of any thickness, width and length. If you want to cut descaling costs to the bone, investigate Pangborn Descaling Machines!

For complete information, send for Bulletin 608. Write: PANGBORN CORPORATION, 4400 Pangborn Blvd., Hagerstown, Maryland.

*U. S. Pat. #2184926 (other patents pending)

with Pangborn Rotoblast® Descaling Machines!

Pangborn

3 BS

BLAST CLEANS CHEAPER

Rotoblast Blastmaster® & Continuous-Flo® Barrel

Rotoblast Tables & Table Rooms

Special Blast Rooms & Cabinets

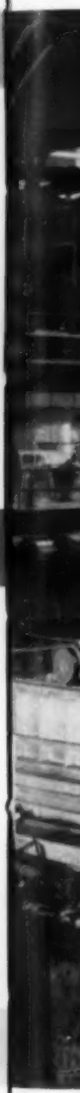
Pangborn Dust Control Equipment

Malleabrasive Shot & Grit

Distributors for Malleabrasive and Tru-Steel Abrasives

The pit nobody liked...

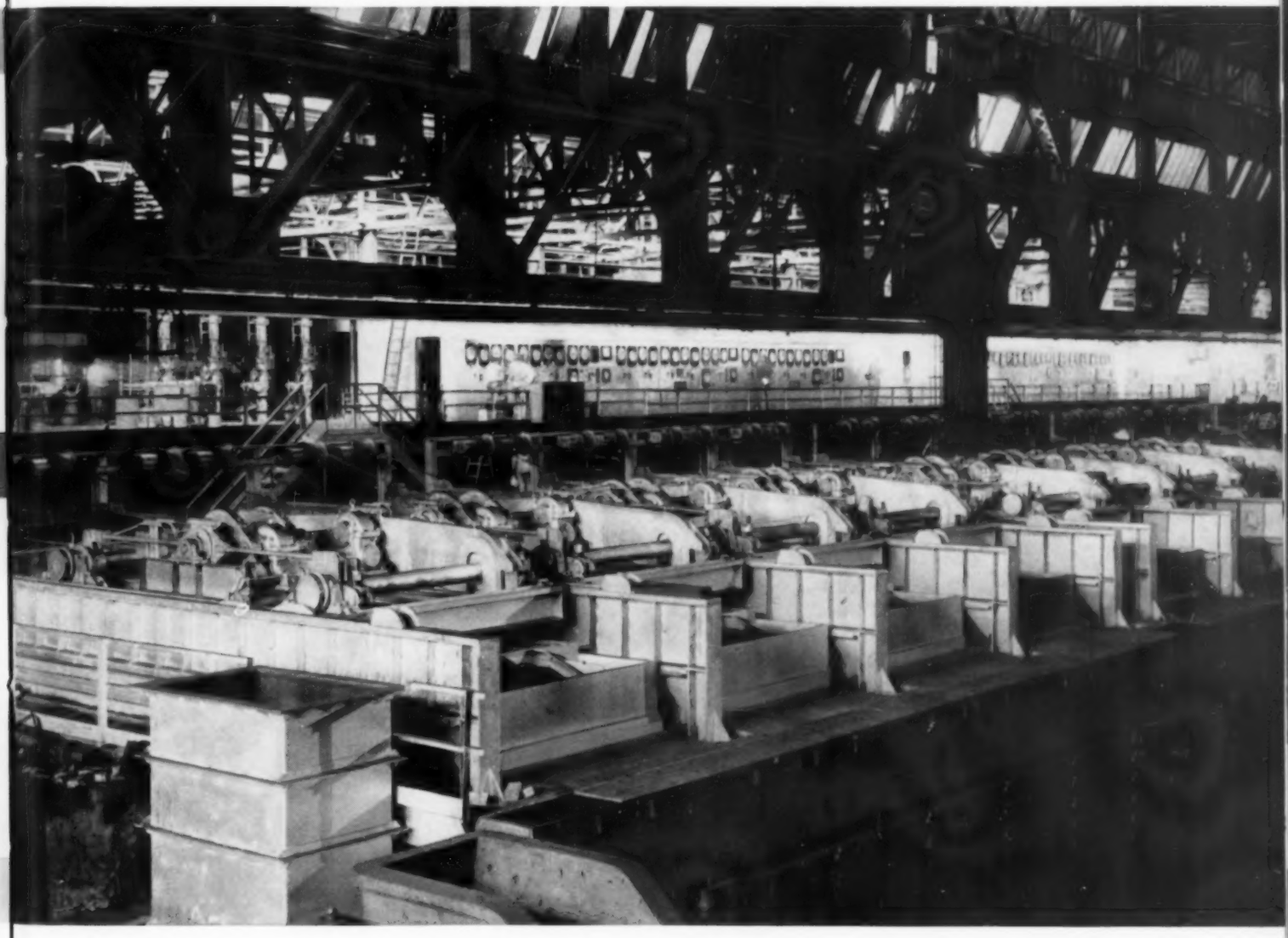
except our customers



This is of course our one-way fired soaking pit . . . fired from the top.

The location of the burner is only one of the features responsible for its enthusiastic acceptance. Most important however are the 30 years of experience and refinements which we have built into the pit since we first introduced it.

That is why, today, it is the pit everybody respects . . . especially our customers.



STEEL MILL, HEAT TREAT, GLASS DIVISIONS

SURFACE COMBUSTION CORPORATION

2404 DORR ST., TOLEDO 1, OHIO

wherever heat is used in industry

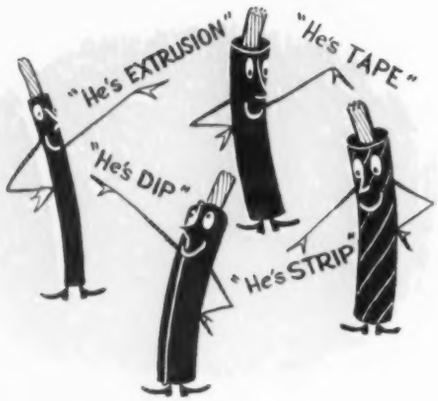
Associated Companies: British Furnaces, Ltd., Chesterfield • Stein & Atkinson, Ltd., London • Stein & Roubaix, Paris • S. A. Belge, Stein & Roubaix, Bressoux, Liege • S. A. Forni Stein, Genoa • Chugai Ro Kogyo Kaisha, Ltd., Osaka • Benno Schilde Maschinenbau, A. G., Bad Hersfeld

Surface®

Hearken to this woeful fable of the man who bought a "bargain" cable

A. C. Current, a budding E. E.
Bought cables from many a source
But he didn't take time to consider, you see
That some last longer than others, of course.

For some circuits *any* insulation will do—
For others, just one type is proper
But Okonite he never consulted, we rue,
As to which one should cover his copper.

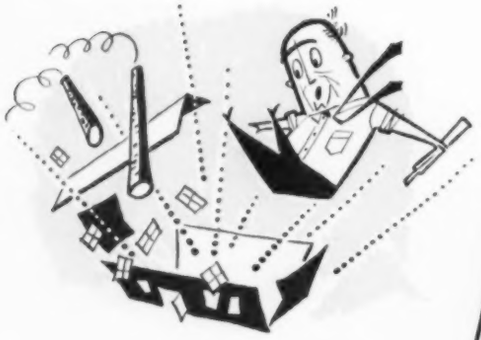


It seems Mr. Current mistakenly thought
(Indeed, 'twas a total delusion)
That Okonite cable would cost him a lot
Whether made by strip, tape, dip or extrusion

Only Okonite insulates cables *all* ways
So our prices are not always highest
And thus when you ask us what cable to use
Our recommendation's unbiased.

The price *does* differ, depending on methods
(The type insulation and how it's applied)
The proof of the pie is in service records . . .
Which we would have gladly supplied.

But A. C., in order to make things look good
Chose a cable he thought was a "buy"
It lasted, we hear, no more than a year,
Then blew him and his factory sky-high.



We hate to relate this horrible fable
But here is a moral for all:
If you should desire a superior cable
By extrusion or strip . . . by taping or dip
Just write us a letter, or call.

No matter *what* insulation or method of application you want (and we use them all) you'll get the best of its kind from Okonite. For a frank, down-to-earth discussion on cable insulating methods, write for Bulletin 15-1106, The Okonite Company, Passaic, N. J.

***where there's electrical power . . . there's* OKONITE CABLE**

4827

TRANTINYL GUIDES THE STEEL INDUSTRY

"TRANTINYL" offers a quarter-century of metallurgical experience. "TRANTINYL" patented alloys were developed to function in specific operations where guides are required to resist wear and abrasion. Users of "TRANTINYL" alloys are astounded at the tonnage rolled over one set of guides.

Join the many satisfied users of "TRANTINYL."

ROLLING MILLS:
bar, hoop, strip, shape mill guides; and rollers.

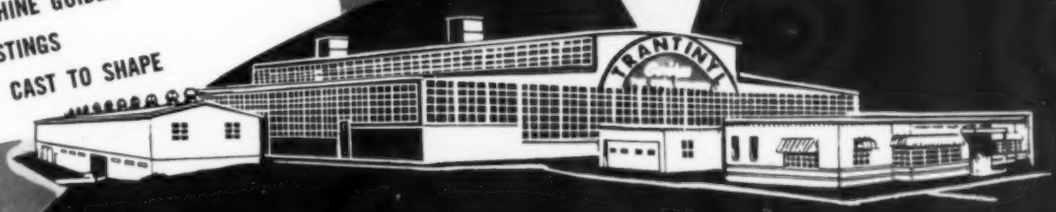
SEAMLESS TUBE MILLS:
guide shoes, rolling mill plugs and rolls, piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS

"TRANTINYL No. 1" CAST TO SHAPE



Youngstown Alloy Casting Corporation

Youngstown, Ohio

5-10

P&H electronic crane control

makes other cranes old-fashioned!

You wouldn't equip your plant with "last year's model" equipment, would you? Then why consider an old-fashioned overhead crane?

If you buy a crane today without electronic control, you're installing a machine that's already obsolete!

There's only one way to guard against this obsolescence . . . and that's by buying P&H — the *only* crane equipped with electronic "stepless" control. You'll get improved control response plus reduced maintenance . . . field-tested and proven with P&H thoroughness in over 300 installations.

Advanced engineering and modern design have continually made P&H overhead cranes first choice for all overhead material-handling jobs. As a result, there are about as many P&H cranes in service today as *all other makes combined!*

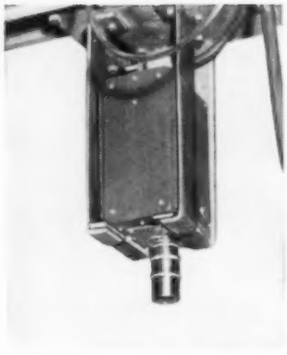
Check this new development, P&H electronic control, before specifying your next overhead crane. Or, modernize your present AC crane installation (any make) with electronic controls.

Write for "Electronic Crane Control," Dept. 105G, Harnischfeger Corporation, Milwaukee 46, Wisconsin.

ON A FURNACE LINE AT A LARGE EASTERN STEEL PLANT

Furnace Operator

"SEES THE END FROM THE BEGINNING" with RCA Industrial Television!



To permit the operator to see around a long furnace line in an alloy plate building at a prominent steel plant, RCA Industrial TV is used. One-man control of the line from beginning to end is thus possible. Six Television Cameras are connected to TV monitors in the control room. A switching arrangement enables the operator to "switch-in" for observation of the blind areas, some of which are more than 600 feet away. He sees everything that's happening and knows when it's safe to move a plate from the quench press.

Other uses for industrial television include remote observation of rolling mills and shears; heat treatment, open hearth and blast furnaces; smoke stacks, fuel burners. Wherever control of vital instruments, processes, or materials is required, RCA Industrial TV can be counted on for reliable, accurate performance . . . designed and produced by the world leader in electronics.

An RCA representative will gladly help you determine how RCA Closed Television can best serve you. Mail coupon below for free literature.

Mark of Quality RCA Tmk(s) ®

RADIO CORPORATION of AMERICA
Camden, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

RCA CLOSED TELEVISION

Radio Corporation of America
Dept. E185, Building 15-1, Camden, N.J.

☐ Please send me latest literature on the use of RCA Industrial TV (Closed Television).

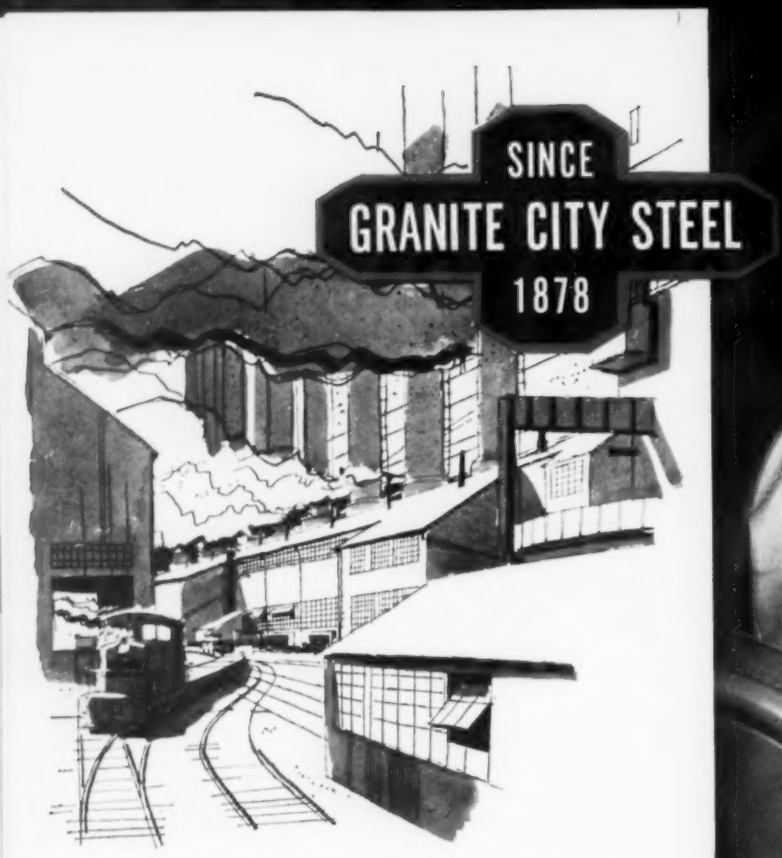
Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

☐ Have representative call.



GRANITE CITY STEEL COMPANY...

"Keeps Rollin' Along"

And Allis-Chalmers steel mill equipment is helping in a new expansion program designed to increase steel production in mid-America

ALONG the banks of the mighty Mississippi, near the geographical center of mid-America, new steel-making facilities are being planned. Granite City Steel Company is planning another major expansion program which will raise their ingot production 30% by early 1958.

Just two years ago, Granite City Steel completed an $89,000,000 expansion. It was the culmination of a 7-year program, in which Allis-Chalmers supplied all major electrical requirements, bringing this midwestern plant up to maximum efficiency.

In this new modernization, Allis-Chalmers steel mill equipment will again play an important role. So far, Granite City has called on Allis-Chalmers for all the necessary electrical equipment needed to revamp their cold-strip mill, and the single-stand temper mill, plus other auxiliary machines.

Allis-Chalmers specializes in mill modernization and expansion. For specific information on drives, control and other electrical equipment for steel mills, contact your A-C representative, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

Other Allis-Chalmers Products for the Steel Industry

Centrifugal Blowers * Axial Blowers * Arc-Furnace Transformers * Mercury-Arc Rectifiers * Rotary Compressors
Unit Substations * Switchgear * Circuit Breakers * Voltage Regulators * Power Generation Equipment

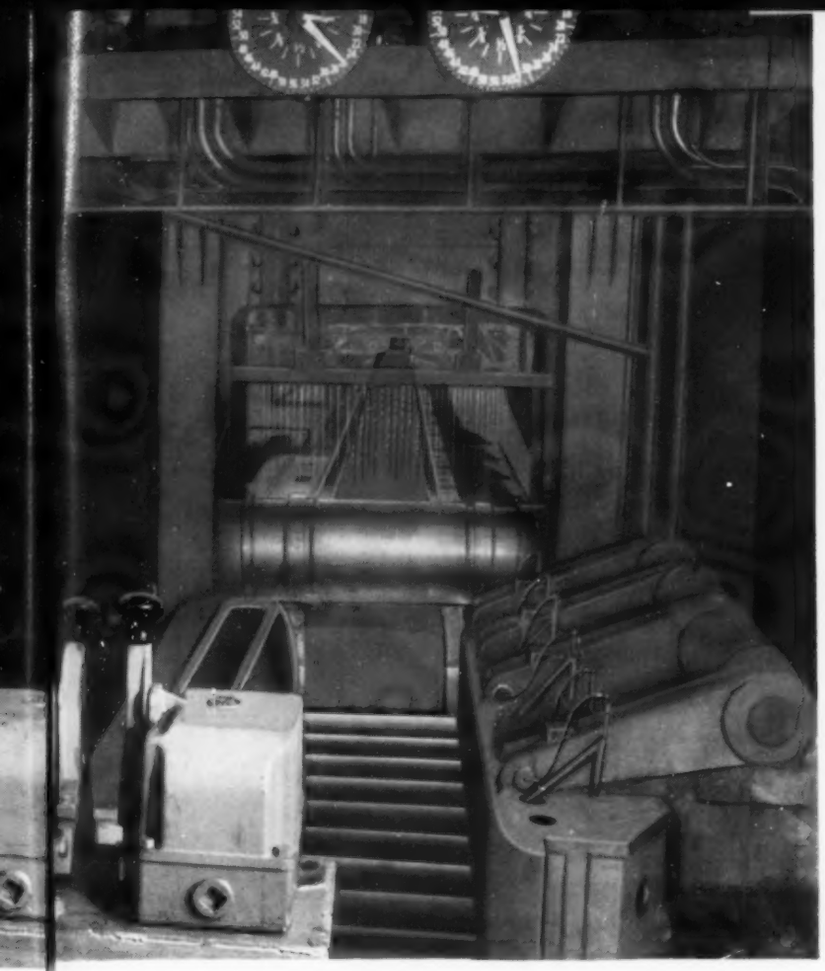
---

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

A-5178

Regulex is an Allis-Chalmers trademark.

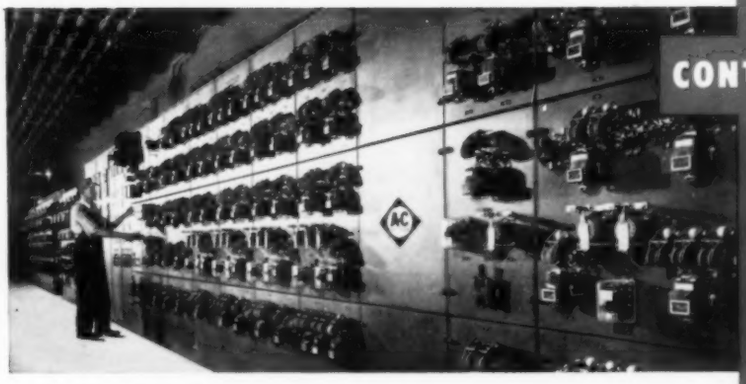


M-g sets supporting cold-strip mill motors. These units are rated at 7750 kw, 514 rpm. Furnished by Allis-Chalmers in 1946, they will be supplemented by new units.

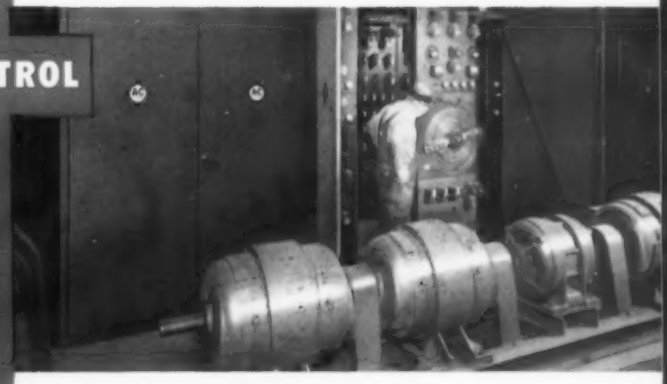
M-G SETS

On the 56-inch temper mill, this 4-machine m-g set supporting the skin pass mill motors will be revamped. Two new 225-kw dc drag generator units will be furnished by Allis-Chalmers for this mill.

CONTROL



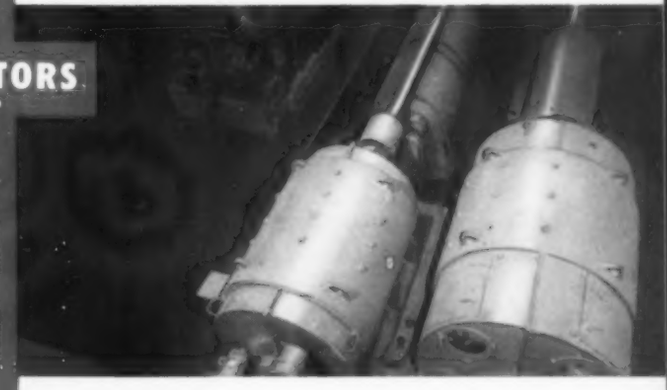
This variable voltage control board is used on the 56-inch tandem cold reduction mill. New control equipment is being furnished by Allis-Chalmers for new mill expansion at this midwestern steel plant.



Regulex control and totally enclosed control board were furnished by Allis-Chalmers in 1948 for the 48-inch temper mill at Granite City Steel Co. Additional control is being furnished for the 56-inch temper mill.

MOTORS

Motor room view at this plant shows Allis-Chalmers units driving delivery reel and main stands. Allis-Chalmers motors furnish drive power throughout the plant. New motors, ranging in size from 25 to 5000 hp, are being installed.



Allis-Chalmers motors shown driving the temper mill include main roll drive, delivery tension, and delivery reel drive. Allis-Chalmers furnished original motors for both temper mills, as well as new motors for increasing capacity.

SIR WILLIAM SIEMENS *brought many inventions to the steel industry but none with a greater future than the electric furnace. Knowledge of the carbon arc dated back to 1800. Siemens put it to practical use in 1878, when he built and operated steel-making furnaces on both the direct and indirect arc principles.*

Even then, electric power was too costly, and carbon electrodes of too poor quality, for an electric furnace to operate commercially. It was another 11 years before a successful commercial direct-arc furnace began operating, in France. America's earliest commercial electric furnace (at Holcomb Steel Company, Syracuse, New York) produced its first heat April 5, 1905. It was of 4-tons capacity. Today there are 200-ton electric furnaces and total domestic capacity exceeds 11 million net tons.

Great Names in Steel Making #V

The growth of the steel industry has been so fabulous that it confers ever-increasing greatness on the work of its pioneers. What William Siemens originated, the industry has since developed to an importance beyond anything he ever dreamed.

This is equally true of more recent technological discoveries.

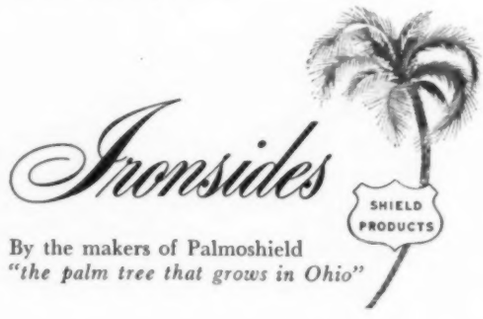
The lubricant Palmoshield, for example, was developed after World War II to replace imported palm oil for rolling tin plate. It was immediately recognized as an important discovery. But, since then, the importance of Palmoshield has been greatly increased by its successful use for the rolling of light and intermediate gauge sheet, and on long terne and coating lines as well.

Most of the rolling mills of North America are today aware that Palmoshield does much more than protect from dangerous dependence on palm oil from overseas. They appreciate that it eliminates the former need for stockpiling and all concern with artificially influenced prices and supply. They value the fact that Palmoshield is produced in the heart of the steel country, from available domestic materials, and under exact chemical control. Fatty acid content can be controlled within ½%.

Moreover, Ironside engineers can and do formulate Palmoshield to suit the mill speed, the method of application and the individual preferences of each user, and guarantee that the compound so developed will not vary in uniformity thereafter.

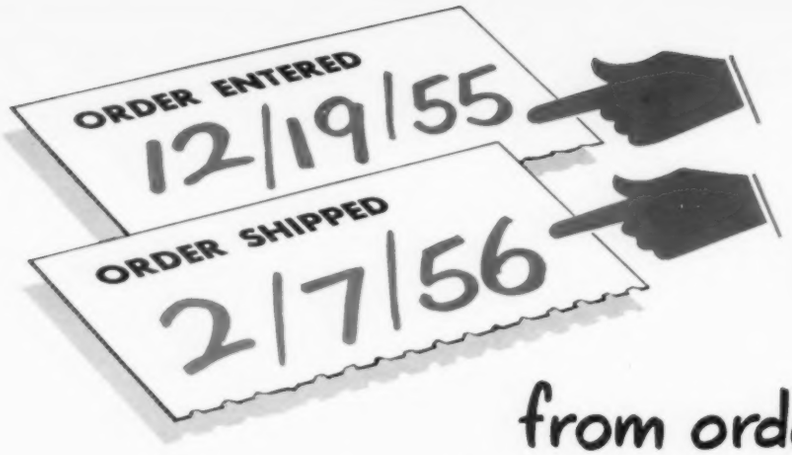
Ironsides lubrication specialists would like to work similarly with you, to help achieve objectives of increased tonnage, reduced costs, and maximum uniformity of mill production. A letter or phone call will bring you complete information and make available the experience of years of successful cooperation with America's major rolling mills.

Address The Ironsides Company, Columbus 16, Ohio.

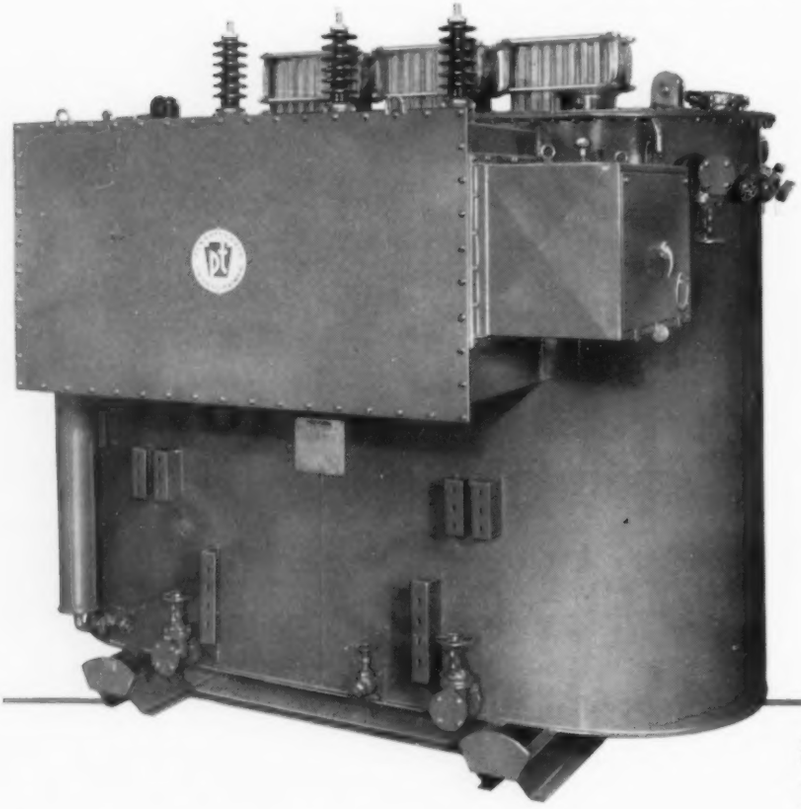


By the makers of Palmoshield
"the palm tree that grows in Ohio"

JOS. MARCULIES.



Only 50 days from order to shipment !



20,000 kva Pennsylvania Furnace Transformer

20,000-kva Pennsylvania Furnace Transformer. Three phase, 60 cycles, water-cooled. High voltage: 24,000 volts. Low voltage: 375 to 250 volts.

The order was entered on Monday, December 19, 1955. 50 days later, on Tuesday, February 7, the finished transformer was loaded on a railroad car and sent on its way to the customer. Like most other furnace transformers, this one was custom-designed and custom-built to meet limiting dimensions. Accessories and auxiliary equipment had to be located on the high voltage side and ends of the tank. Low voltage bus work had to match existing facilities.

A 50-calendar-day delivery for a 20,000-kva furnace transformer is not an everyday requirement at Pennsylvania, but when circumstances demand it, deliveries such as this can be made.

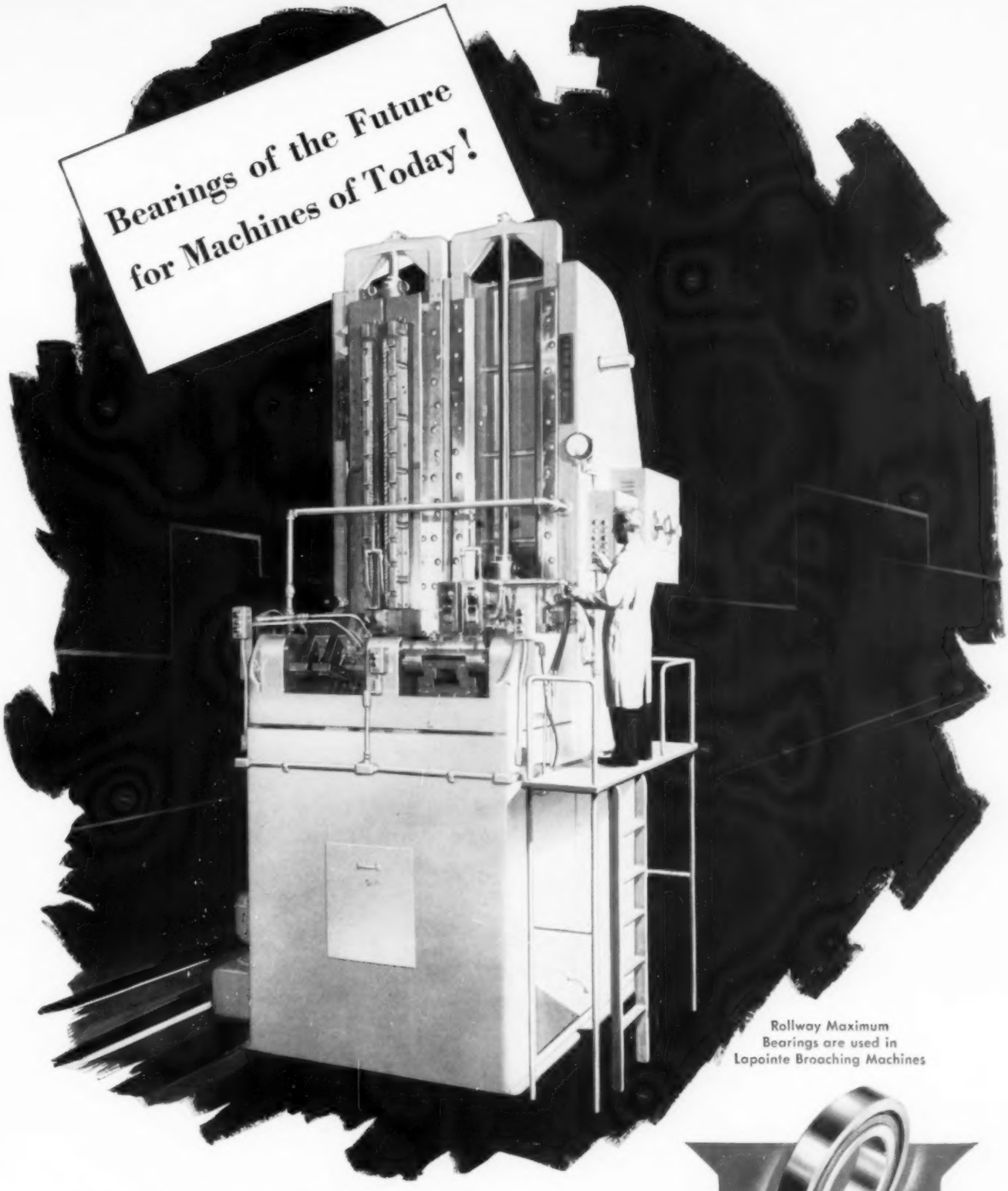
Sixteen years ago, in 1940, Pennsylvania was called upon to design and deliver a 15,000-kva, 3-phase, 25-cycle furnace transformer in record time. A large transformer by today's standards, it was even more so a decade-and-a-half ago. Pennsylvania designed, built, and shipped that transformer in 35 calendar days and it is in active service today in a large steel mill.

Which all boils down to this:

If you have a furnace transformer problem — whether it involves short-time delivery, special requirements, or unusual design problems — it will pay you to consult Pennsylvania.

PENNSYLVANIA TRANSFORMER COMPANY
A McGraw Electric Company Division CANONSBURG, PA. Greater Pittsburgh District

Bearings of the Future for Machines of Today!



Rollway Maximum Bearings are used in Lapointe Broaching Machines

Rollway roller bearings regularly offer performance capabilities for more than the needs of today. They are continuously anticipating the operating requirements of years ahead.

Wherever bearing precision and load values are important in your plant or products — for original equipment or replacement service — call on Rollway *bearings of the future*, to give you the utmost performance in your machines of today. Rollway Bearing Company, Inc., Syracuse 4, N. Y. Manufacturers of a complete line of radial and thrust cylindrical roller bearings.

ROLLWAY®
Maximum
ROLLER BEARINGS

ENGINEERING OFFICES: Syracuse • Boston • Chicago • Detroit • Toronto • Pittsburgh • Cleveland • Milwaukee • Seattle • Houston • Philadelpia • Los Angeles • San Francisco

Lectromelt

by agreement with

Demag-Elektrometallurgie, G. m. b. H.

Duisburg, Germany

is pleased to announce that they now have the exclusive license in the United States and Canada for the manufacture of

DEMAG ELECTRIC SMELTING FURNACES

for all smelting, refining and reduction operations

●

You are invited to send requests for engineering service or product information to

LECTROMELT FURNACE DIVISION

Mc Graw-Edison Company

310 32nd Street • Pittsburgh 30, Pennsylvania

By
H. I. SMITH
Assistant Superintendent
Rolling Mills
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

THE NEW 10-IN. BAR MILL— Jones & Laughlin Steel Corp.

Figure 1 — The new 10-in. mill with sixteen stands delivers small merchant bar sections at speeds up to 3000 fpm

. . . . new bar mill has a rated capacity of 30,000 tons per month . . . . it is a 16-stand continuous repealer unit . . . .

▲ TO make available, the area required in our corporation's recent vast expansion program it was necessary in 1950 to dismantle two bar mills that had been in operation since 1900 and 1909, leaving the burden of producing these commodities on a bar mill of a limited size range and capacity, and itself of an antiquated, steam driven design built in 1916.

Recognizing the necessity of reentering a market that was no longer available due to the limited range of sizes and sections to roll on this mill, an appropriation was granted for the construction of a new bar mill.

The site selected was in an area that contained a reserve coal pile of 244,000 tons that required about two and one half months for removal in order to provide the space necessary for the mill, billet yard and railroad storage tracks.

Ground was broken March, 1951, and to present some idea of the magnitude of the construction project; 78,000 cu yd of excavations were removed; 21,000 cu yd of concrete poured; 900 tons of reinforcing bars used; 4140 tons of steel required for buildings and runways and 22.5 miles of conduit laid.

The mill, housed in a building 1350 ft long x 110 ft wide, is known as a 16-stand continuous repeater mill, of a rated capacity of 30,000 tons monthly in a size range as follows: rounds $^{19}/_{64}$ to $1^{1}/_{4}$ in.; squares $^{9}/_{32}$ to $1^{3}/_{32}$ in.; hexagons $^{9}/_{32}$ to $1^{3}/_{16}$ in.; concrete reinforcing bars $^{3}/_{8}$ to 1 in.; flats $^{17}/_{32}$ x $^{5}/_{32}$ in. to $2^{1}/_{2}$ x $^{1}/_{2}$ in.; nut flats $^{15}/_{32}$ x $^{7}/_{32}$ in. to $1^{1}/_{8}$ x $^{7}/_{8}$ in.; angles $^{3}/_{4}$ x $^{3}/_{4}$ in. to $1^{1}/_{2}$ x $1^{1}/_{2}$ in. in width with thickness corresponding to standard sizes covered in the steel products manual, and special sections as outlined by our roll engineering department.

Figure 2 — Three pouring reels are used when rolling coil.

On January 26, 1953, the first attempt at rolling succeeded in getting a bar through the finishing stand. On January 27, 1953, 49 billets, 2½ x 2½ x 30 ft-0 in. for a finished tonnage of 14 tons were rolled into 9/16 in. rounds and on January 29, 1953, 165 billets totalling 42 tons were rolled into 9/16 in. rounds. All rolling was in coil form until the completion of the cooling beds, April 24, 1953. With the initial operation underway, began the period of training crews, making adjustments to equipment and ironing out the "kinks" so prevalent with the start of a new mill.

Billets of a size range from 2 x 2 in. to 3⅛ x 3⅛ in. x 30 ft, weighing 400 to 960 lb produced at the billet mills of both Pittsburgh and Aliquippa works are delivered in railroad cars to the billet yard of a storage capacity of approximately 8000 tons served by two 20-ton cranes.

Billets are placed upon a holding platform moved forward to the "bundle buster" where they are alined for deposit on the table rollers and thence moved forward to the rear of the furnace, where they are pushed into the furnace by means of a rack and pinion type pusher. Designed billets can be rejected by arms that pick up billets at the roller table and deposit them in a packet at the opposite side of roller table.

The furnace, end charged, side delivered is a two zone suspended roof type, with an effective heating length of 60 ft, using as a fuel, coke oven gas and/or tar or oil, with a hearth temperature of 2200 to 2300 F. Furnace is equipped with the most modern instrumentation possible, has a rated capacity of 90 tons per hour with an average fuel consumption of 1,300,000 Btu per net ton heated.

Upon being pushed from the furnace by means of a peel, the billet enters a set of pinch rolls, directly beyond which is located a motor operated upcut shear that can be used to cut the billet to a desired length or do any cropping necessary. The billet is delivered to the first roughing stand over an entry roller table 29 ft-4 in. in length.

The roughing mill consists of eight stands as follows: No. 1 and 2, 16 in. pitch diameter x 36 in. face, driven through a gear reduction by one 600-hp motor at 175 to 525 rpm; stands No. 3 to 8, 15 in. pitch diameter x 36 in. face, driven in pairs, through gear reductions by three 800-hp motors at 300 to 900 rpm. Passes are alternately diamond and square when rolling rounds, squares, hexagons or reinforcing bars, and a series of flat and edging passes when rolling angles and flats. Roller twist guides are used on the diamonds with hanging guides for the delivery of the square. All stands are mounted on sliding bases to permit shifting to any desired pass line. Shifting is done through use of hydraulic oil cylinders. At the delivery side of No. 8 stand is located a crop shear, operating from the impulse of a photo-electric cell at entry of No. 7 stand, on a timing relay. This crops off desired length of front end, or when operated manually from pulpit, cuts up passing bar in the event of a cobble beyond No. 8 stand.

The intermediate stands (No. 9, 10, 11 and 12) are 13 in. pitch diameter x 26 in. face, driven by individual motors. No. 9 stand is driven direct by a 600-hp motor at 175 to 525 rpm. No. 10 stand is driven through a gear reduction by a 600-hp motor at 250 to 625 rpm. No. 11 stand is driven direct by a 700-hp motor at 250 to 625 rpm. No. 12 stand is driven through a gear reduction by a 600 hp motor at 250 to 625 rpm.

Stands No. 9, 10, 12 and 13 can be retracted and the two 180-degree movable repeaters, of 7 ft-0 in. radius, positioned so that it is possible to use 8 stands, 7 stands, 6 stands, 5 stands or 4 stands after the roughing mill. The odd number of passes can be used for special shapes. Twisters are mounted at No. 9, 10, 11, and 12 stands for use when needed.

The finishing train consists of four stands in tandem. No. 13 and No. 15 are vertical stands of 11 13/16 in. pitch diameter x 20 in. face. No. 13 stand is driven through a gear reduction by a 1000 hp motor at 350 to 875 rpm. No. 15 stand is driven through a gear reduction by a 700-hp motor at 450 to 1070 rpm. No. 14 and No. 16 are horizontal stands of 10½ in. pitch diameter x 20 in. face. No. 14 stand is driven direct by a 1000-hp motor at 350 to 875 rpm. No. 16 stand is driven direct by a 800-hp motor at 500 to 1150 rpm. Vertical stands can be elevated or lowered by means of electrically operated screws to a fixed pass line of approximately 32 in. above floor line. Horizontal stands can be shifted to any desired pass line hydraulically; speeds on finishing stands vary up to 3100 fpm; roller guides are used at No. 14 and 16 stands when rolling rounds or hexagon. Side and up loopers are used between the stands in intermediate and finishing mill, manually operated from the mill pulpit. Kickers, operated on photoelectric cell impulse activating an air cylinder elevate the bar from the repeaters. Snip shears operated from the mill pulpit are located ahead of stands No. 10 and 13 and used to keep scrap in the mill to a minimum in case of a cobble. All stands are equipped with top and bottom roll adjustments and hydraulic roll separation. Fibre bearings in steel chucks are used throughout the mill.

After leaving the finishing stand, the bar is either delivered to the coilers or onto the cooling bed. If to the coilers, it passes through a lead pipe, then by action of photoelectric cell activating relays, a sequence of operation is instituted through the dividing pipes leading into three pouring reels, from where the coils are deposited onto a slat conveyor, of 30 ft-10 in. in length, pushed onto a drag conveyor by means of photoelectric cell actuating a pusher timed always to deposit coil in the front of a dog on the conveyor, and conveyed on the drag conveyor of 189 ft-5 in. with dogs spaced 7 ft-6 in. apart. At the end of this conveyor they are picked off by hooks on a trolley conveyor of 196 hooks spaced 8 ft-0 in. apart and conveyed to the end of the building where they are automatically tripped off and deposited on a coil unloader to be removed by cranes. The hook conveyor, 1600 ft in length, has a holding capacity of 121 coils, with 75 empty hooks in return. Testing of coils for defects is done to some extent, on the smaller sizes of cold heading rounds while coils are on hooks.

Straight bars after passing through finishing stand are delivered onto divided flow cooling beds 367 ft-0 in. in length x 35 ft-10 in. in width. If producing a section from a billet weight in excess of the length of the cooling bed, it is cut by a rotary shear located 45 ft-0 in. from the finishing stand. This shear, with a fixed bottom rotary knife and a rotating top knife, is operated when bar is pulled between the knives by a

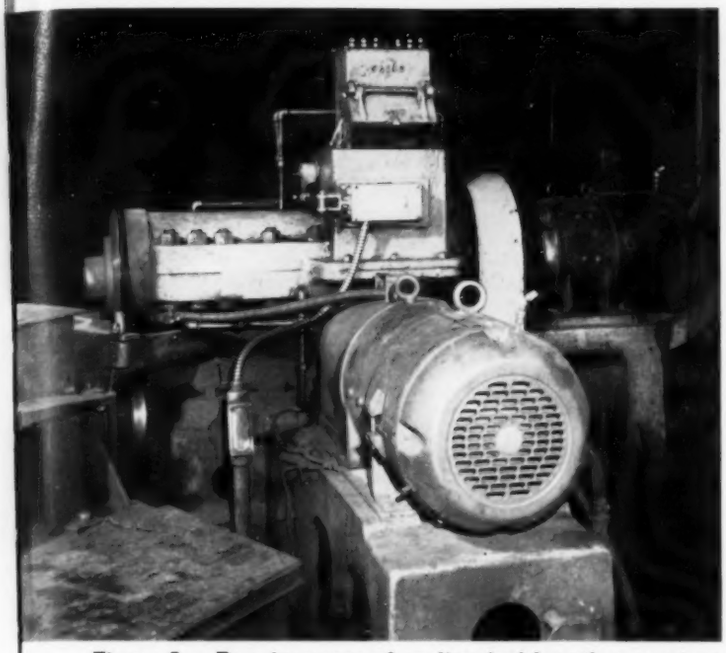


Figure 3 — Bars in excess of cooling bed length are cut on rotary shears.

Figure 4 — To deposit bars cut at rotary shears or in full length onto alternate cooling beds, this switch is used.

trough located ahead of shears. It is activated when the bar moving down the hot run table passes over an electrically contacted roller, with spacing established through performance, which delivers a signal to a relay that operates a switch that actuates the trough and the shears.

At a distance of 16 ft from the rotary shears is located an air operated switch that is of utmost importance to the operation of the mill. When necessary to cut bars with the rotary shears because of excess length on a section in excess of the capacity of the cooling bed, some means must be found to properly distribute the lengths cut from a billet, onto alternate cooling beds or to split the billet, before entry into the mill, into lengths suitable to the cooling bed. Such splitting is entirely impractical on small sections where the weight of the billet exceeds the capacity of the cooling bed by as much as 400 to 500 per cent.

Various methods were tried, numerous switches were built, nothing was gained in the attempt to properly deliver the sections requiring rotary shear cutting onto the divided flow cooling bed, then the roller on the mill suggested a two-way trough switch combining the horizontal motion for positioning only at the run out level, with the necessary vertical position for the entry of bar. After being detailed and built, the problem of delivering sections requiring cutting to fit the capacity of the cooling bed was solved. The switch consists of two rectangular boxes $3\frac{1}{2}$ x $5\frac{3}{4}$ in. x 6 ft long, four air cylinders and four limit switches. The mechanism is set on a lubricated base and moves up and down and sideways on slides, powered by aire ylinders and energized by solenoid valves. When switch is ready to receive bar, the boxes or funnels are set one above the other. The bar passes through the bottom funnel, travels about 50 feet, at which point it comes in contact with an insulated roller. When contact is made, an electronic relay is picked up, which in turn institutes a control relay. This energizes solenoid operated air valve. This valve puts air into the cylinder which

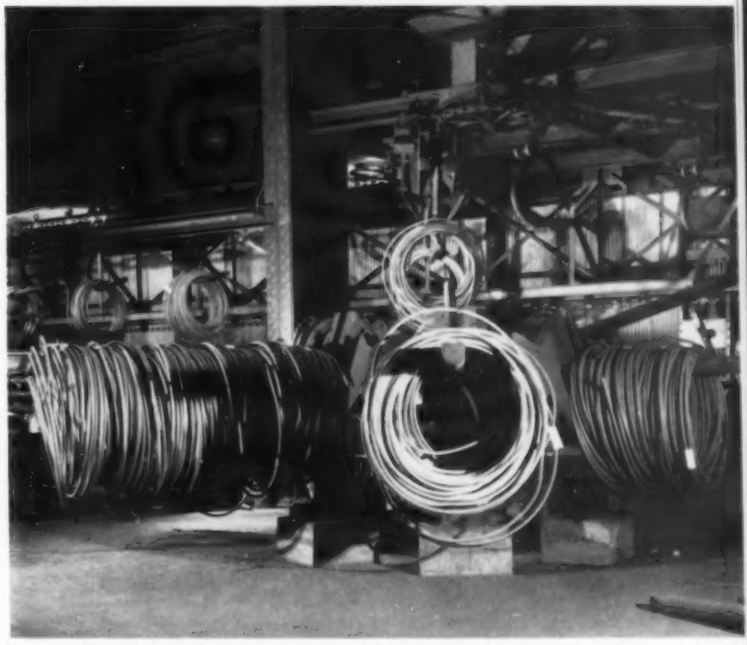


Figure 5 — The rotating six-arm unloader collects the coils from the hook conveyor in lifts of five or six to a bundle to be further processed or placed in cars for shipment.

moves the top funnel sideways and down. Then a lever contacts a limit switch which sets into motion another solenoid-operated air valve for the cylinder which lifts the bottom funnel out of the way so that funnel which was on top can slide into the lower position to receive the next bar. This cycle reverses itself for each bar, if both hot beds are used. If only one bed is used, switch is positioned for whatever side to be used, and all switches are pulled, holding the switch in a stationary position.

The idea of the switch, born in the mind of the roller, paid off handsomely, as he was the recipient of one of the largest awards in industry, paid by our corporation under the suggestion system.

After passing through the switch, the bars moving

over the hot run in rollers to the cooling bed, pass over electrically contacted rollers (of which there are eleven set at desired lengths), and actuated by timing apron lifts located between the rollers on the cooling bed run table. These elevate and retard or stop progress of the bar, when another limit switch and relay actuate by timing, the kickers, which are arms spaced two arms to each 36 in. of bed, kicking the bars into fixed notched grooves. Here they are lifted by movable notched racks that are also actuated by a limit switch and relay which move the racks or carry over forward. Bars are then shuffled onto the roller tables and delivered to the shears to be cut on two shears of 500 tons knife pressure. The shears, equipped with knives of 42 in. length, are driven by 75 hp motors at 900 rpm and the bars are weighed on electrically recorded scales of 25-ton capacity.

GENERAL

While the mill has not produced at its rated capacity of 30,000 tons per month at this writing, the performance has been gratifying in recent months.

Some production figures are:

Average hourly production in December, 1955, 42.47 tons per hour the eight-hour turn record rolling on 1 in. round is 658 tons the day record is 1615 tons and monthly record, in March, 1956, was 29,955 tons.

MILL AUXILIARIES

The mill auxiliaries consist of the following:

1. Mill crane—one 25-ton hoist with one 5-ton auxiliary.
2. Shear and shipping cranes—two 20-ton hoists with 5-ton auxiliary.
3. One hydraulic water descaling system located before entry to roughing mill of a capacity of 250 gpm at a pressure of 1300 psi.
4. One cobble baller.
5. Ten spare set up stands to expedite roll changes.
6. Air-conditioned motor room houses all motor-generator sets, rectifiers, controls, meters, etc. The total hp generated is 11,500 for a capacity requirement of 9000 hp.
7. Mill pulpit contains all mill drive controls. Operator can alter speeds of any pair of roughing, any individual intermediate or finishing stand or collectively the entire mill. There are vernier controls on the mill floor for making minor speed adjustments to the roughing train.
8. Coiler pulpit contains all coiler drive controls. Operator can adjust speeds of any or all pouring reels to suit operating conditions. Normally, once speed of reels are set, reels follow speed of finishing stand.
9. Roll shop for servicing rolls. Equipment consists of three 18 in. roll lathes for servicing finishing and intermediate mill. Roughing rolls are serviced at central shop.
10. Inspection benches.
11. Bar straightener.

MAINTENANCE

Since breakdowns of any nature reduce the operating rate and increase costs, considerable time and thought was given to design to insure that maintenance would be held to an absolute minimum. Some of the installations conducive to efficient operations are:

1. Lubrication system of which there are seven motor and twenty-seven manually operated centralized systems. Of the seven motor-operated systems, one serves the pinch rolls, upcut shears and roughing mill entry tables; one, the bundle buster; one, the two shear discharge tables; one the hot run in roller line to the cooling bed and three serve the double hot run table, apron lifts, line shaft bearings for shuffle bars and both cold run tables to the shears. The twenty-seven manually operated systems serve the remainder of the mill.
2. Circulating oil system—one motor-operated circulating oil system serves all the pinion stands and drives, pouring reels and furnace delivery pinch roll bearings, contained as a centralized system, one motor operated self contained system for furnace pusher, and two motor operated self contained systems for the mill shears.
3. Gear type spindles on all intermediate and finishing stands for quick removal.
4. Maintaining of weekly inspection schedules helps insure against maintenance breakdowns and adherence to these schedules prevents a major part of unscheduled maintenance work.

DISCUSSION

PRESENTED BY

E. C. PETERSON, Vice President Charge Engineering, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

H. I. SMITH, Assistant Superintendent Rolling Mills, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

SHERIDAN A. SMITH, Superintendent of Rolling, Steel Co. of Canada, Hamilton Works, Hamilton, Ontario, Canada

F. G. KREDEL, Chairman Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio

WILLIAM L. STOVER, Division Engineer, Mesta Machine Co., West Homestead, Pa.

GORDON M. BAKER, Plant Engineer, Universal Cyclops Steel Corp., Universal Division Bridgeville, Pa.

E. C. Peterson: The layout of this mill presents a number of interesting features. The straight continuous bar mill is well known, as there have been several notable recent installations. It is obvious that in such a mill we have the advantages of high finishing speed and, as a function of high finishing speed, the ability to use heavy weight billets and still stay within reasonable size variations on finished bars. Labor is kept at a minimum. As a result this type of mill has been quite popular recently.

Also, through the years there has been consistent use of the open type of bar mill, especially mills with open finishing trains.

Figure 6 shows a recent installation of a successful bar mill. There are some continuous roughers on the right, and, on the left side, an open finishing mill, with transfer and skew tables.

Such a mill has an advantage in that speed regula-

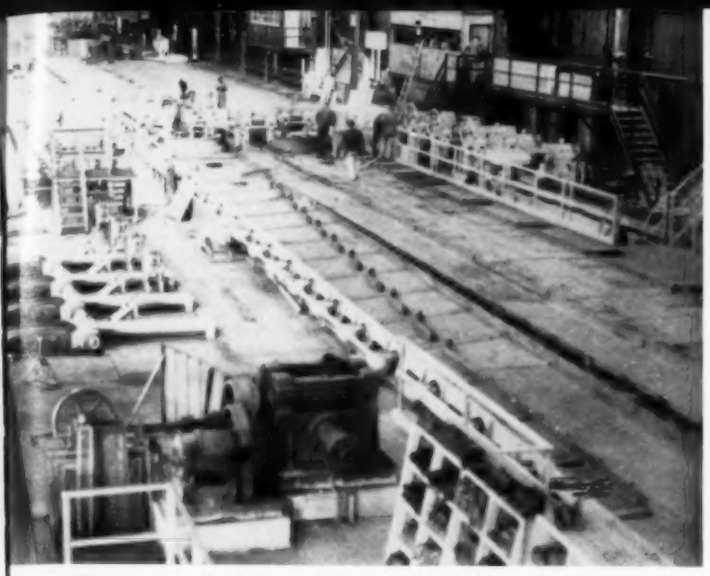


Figure 6 — In this mill speed regulation is not as critical as in the high speed continuous mill.

tion is not as critical as in a high speed continuous mill. In the finishing passes, the bars run out, either in repeaters or straight out on a transfer table, and therefore, the speed relationship between the stands is not so sensitive.

Further, it gives the roller a better chance to see what is going on between passes, and if it is mechanized with the auxiliaries that are available today, uses a minimum of direct labor.

The stands can be arranged for finishing at various points without disturbing unused stands.

So, an open mill, while it does not have as high a finishing speed as a high speed mill, might be considered more flexible.

The interesting part of the J & L bar mill is that it appears to be a compromise between the above two types. It is not straight continuous, and yet it is not open in the sense of the conventional Belgian mill in that there are continuous, intermediate and finishing trains.

I would like to ask Mr. Smith what considerations prompted the adoption of the layout.

Mr. Smith also mentioned that diamond and square breakdown passes are being used. This type of reduction does not permit as high reductions as oval and square.

We have recommended and seen used successfully oval to edged oval passes on material which has shown a tendency to fold in going from a square to an oval. These reductions are also quite light.

Most of the new installations of alloy and specialty mills use oval and square reductions, and this method has a great advantage for specialty steel rolling because it is very convenient to reduce or increase stock in making the ovals, by making them thinner or thicker as required for the various grades.

The diamond and square reductions are not so flexible for changing of stock because it is necessary to let the passes fill up.

I would like to ask Mr. Smith what his experience has been with this type of reduction, and whether he feels that the quality improvement makes up for the lighter reduction and loss of flexibility.

H. I. Smith. The mill layout of a somewhat compact nature was selected after careful consideration, as the mill that would meet our requirement and at the same time be suitable for the area that was available for its construction. The 10 in. bar mill is using the diamond and square method of rolling. In rolling rounds the last four stands are ovals and rounds. The quality of our product is entirely satisfactory and we believe the diamond and square method of rolling to be the equal of any.

Sheridan A. Smith: I would like to ask Mr. Smith, what is the minimum tonnage he placed on this mill and do you have much difficulty in starting an order. You mention in your paper you were driving the mill with independent motors. Do you have much trouble adjusting these motors?

H. I. Smith: Our average tons per section of all commodities is 140 tons. We will however, accept a size for as little as 20 to 25 tons.

We did have difficulty when the mill first operated in starting an order, which was due principally to the lack of experience of the operating personnel. At the present, we have only the normal amount of trouble starting sections.

We do not have any problem in adjusting motor speeds as all sizes and sections are chartered to the proper speed.

Sheridan A. Smith: On your motor regulation, is it really necessary to have them equalized very close, or do you find that one motor will pull another? What I mean by that is, if you should get a fluctuation where one motor speed is slow, do you find one motor pulls and releases the load on the other?

H. I. Smith: The mill motors are equalized closely. Not to do so would find one motor exceeding the speed ratio of the other, giving a resultant push or pull between stands that would result in off section product or cobbles.

F. G. Kredel: You mentioned hydraulic separators between top and bottom rolls. Is this setup used throughout the mill? Do you find it advantageous on a mill this size?

H. I. Smith: Yes, we do, and by such separation throughout the entire mill, we find it to be much quicker when making adjustments to stands and also find it more constant.

William L. Stover: On your flying shear at the finishing stands, do you do any cropping on this shear? If so, how do you get rid of the crop ends?

H. I. Smith: The rotary shear beyond the finishing stand is used only for cutting bars in lengths in excess of the cooling beds and not for cropping.

Gordon M. Baker: Please give us a brief description of your method of hydraulically shifting the mill stands.

H. I. Smith: Horizontal roll housings on stands No. 1 to 8, No. 11, 14, 16 are shifted hydraulically. On the underside of these stands and pinion housings, are connected the pistons of hydraulic cylinders that are used to place roll housing at desired position. Both pinion and roll housings of each stand are mounted on the same sliding base that are held to the bed plate, by tapered blocks through which bolts held tight by keys secure the sliding base to the bed plate. As any movement is desired, the keys at the pinion and the roll housings are loosened and such motion by cylinder made. On stands No. 9, 10, and 12, the same method is used except movement is by electrically driven screws instead of hydraulic cylinders.

Continuous Annealing Lines for Tinplate — Recent Trends and Problems

. . . . continuous annealing lines give uniform product and higher strength, allowing thinner gage steel to be used . . . . better corrosion resistance properties are characteristic of the processed metal . . . .

By

J. H. HOPPER

Manager Application Engineering

User Industrial Sales Dept.

East Central District

General Electric Co.

Cleveland, Ohio

and

A. JAKIMOVICH

Steel Mill Systems Engineering Section

General Electric Co.

Schenectady, N. Y.

▲ THE modern continuous strip annealing line for tinplate is an unqualified success. Informed sources predict that in less than ten years, approximately 90 to 95 per cent of the tinplate rolled in this country will be annealed in similar continuous lines, compared to less than 20 per cent at present.

Basic reasons for the success of these lines are:

1. The can companies like the product.

2. The process is now economically competitive with box annealing, if the complete mill production cycle is considered.

Some observers believe that the transition from box annealing to continuous strip annealing will be completed within five years. This is not unlikely, however, it seems reasonable to assume that the can companies will dictate the time table for this transition. Why do the can companies like the product?

1. First and most important is uniformity. With the continuous anneal, every part of the coil is exposed to the same annealing conditions, which obviously is not true with the batch process. With the great strides made by the can industry in automation, this quality is extremely desirable.

2. The higher tempers, uniformly and readily obtained by the continuous annealing line, make possible a considerable saving because the required strength and stiffness can be obtained with thinner gage steel.

3. Superior corrosion resistant properties of base metal are obtained.(4)* This should result in some lengthening of the average shelf life of canned products.

What are the factors to be evaluated by the steel companies in making a realistic and fair cost comparison of the box annealed product versus the continuous annealed product?

1. Direct costs of the two annealing processes, including fixed charges on investments, direct labor, overhead, fuel and power. With the present lines, this comparison alone will favor box annealing. The cleaning line costs, as well as upenders and downenders, and all associated material handling costs, should be considered a part of box annealing costs, since the continuous annealing line performs or eliminates all these functions.

2. Evaluation of mill building space used for both processes. The box anneal process should be charged with all coil storage required which is not needed with the continuous annealing process.

3. The amount of steel in process inventory must be considered. It must be recognized that even with the most modern batch annealing equipment, it still takes five days to process the strip through the annealing and cooling operation, while with the continuous operation this time delay can be almost eliminated.

4. The performance of the subsequent processes after annealing as well as the preceding processes, must be considered. The absence of stickers, improved flatness of the strip, less damaged coils due to less coil handling, less reduction required in the temper rolling, all help to increase the tonnage output of the temper mill and continuous tinning line after the

* Numbers refer to Bibliography at end of article.

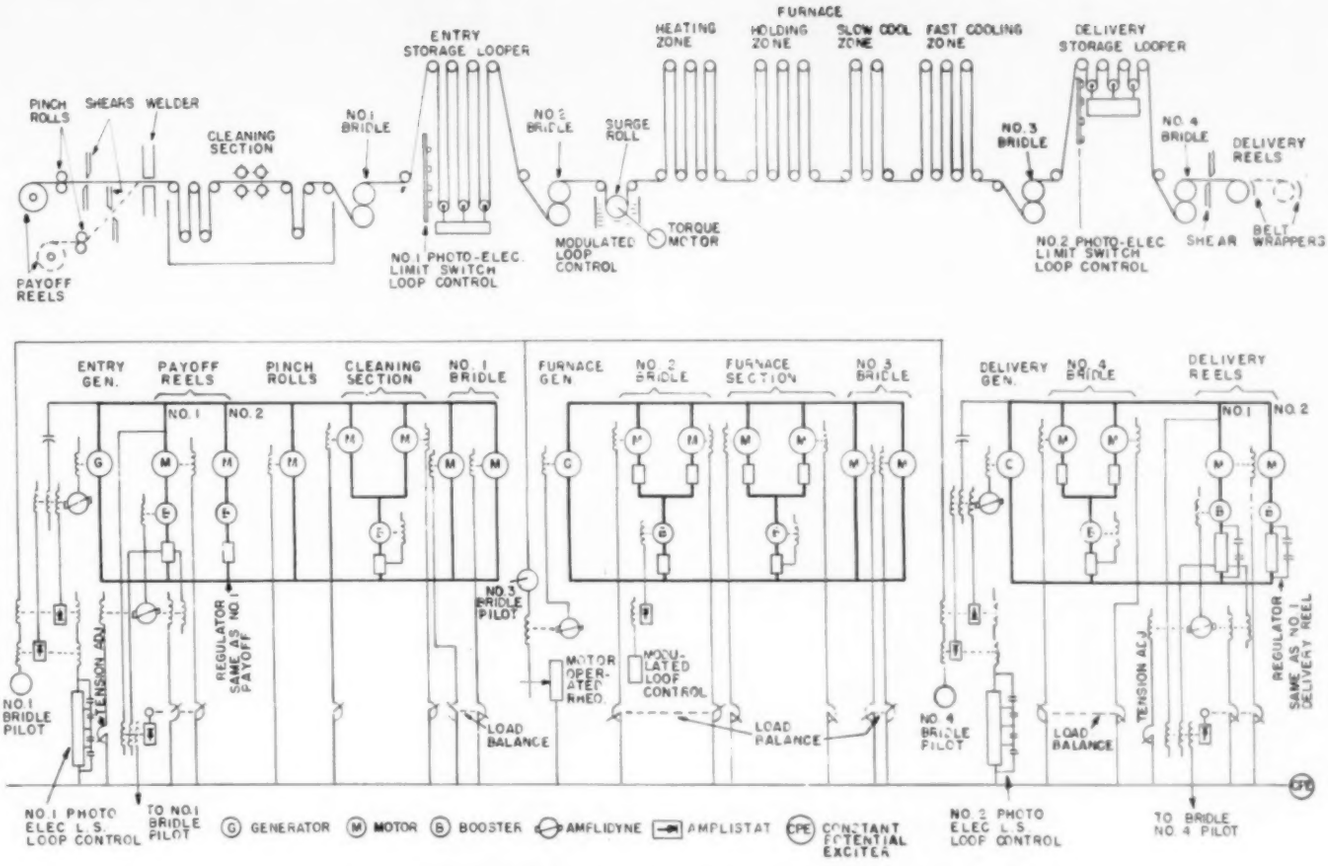


Figure 1 — Schematic layout of typical continuous annealing lines.

strip is annealed by the continuous operation. Also, much of the present output of continuous annealing goes into the T6 temper, used in many special applications in the can industry. This temper is readily obtained on continuous annealing lines without excessive temper rolling afterwards, and with a steel whose chemistry makes it easier to handle in the reduction mills and processing lines.

5. Another point that may be difficult to directly relate to cost, but should be considered, is the reduction in the number of grades of tin plate. There are now 11 different grades of box annealed tinplate. Most of these can be satisfactorily replaced with about three or four grades of the continuous annealed product. This reduction in the number of grades handled should provide some savings in inventory for both the steel companies and the can companies.

GENERAL DESCRIPTION

A schematic layout and one line diagram of a typical continuous annealing line is shown in Figure 1. The line drives divide naturally into three basic sections; the entry section, the processing or annealing section, and the delivery section. Separate generators are used for each section and strip storage facilities are located between the three sections. This permits the exit and entry sections to be stopped for coil changes and still maintain a continuous strip movement through the furnace.

The tread speed of the line is 1000 fpm, but the electrical scheme would be essentially the same for a 2000-fpm line. Regarding the line speed, the trend of thinking seems to be definitely toward the 2000-fpm speeds. However, many problems remain to be solved before lines operating at this speed can prove themselves to be more practical than the slower speed lines. For one thing, the entry storage looper should have sufficient storage to provide time for making a weld with the line running at full, or near full speed. This and other mechanical factors will be discussed later in the text. At this point, it should be said that these problems relative to successful operation of a 2000-fpm line can and will be solved in the near future. The reduced costs achieved by higher speeds will make the process even more attractive to the steel companies.

Another factor in the operation of a high speed line is the size and quality of the coils. Very large coils of high quality strip would naturally tend to be favorable to a high speed line. It is possible, however, that strip with poor shape, excessive camber, or questionable welds might have to be run at very much reduced speed. Therefore, the quality of the steel, the quality of welds, and the size of the coil are important considerations in making use of the top speeds in a high speed line.

ENTRY SECTION

The entry section is made up of two expanding type pay-off reels, double wheel seam welder, shears and required pinch rolls. Figure 2 shows a view of a typical entry section.

This equipment has been designed to minimize the amount of time necessary for a coil change. The two

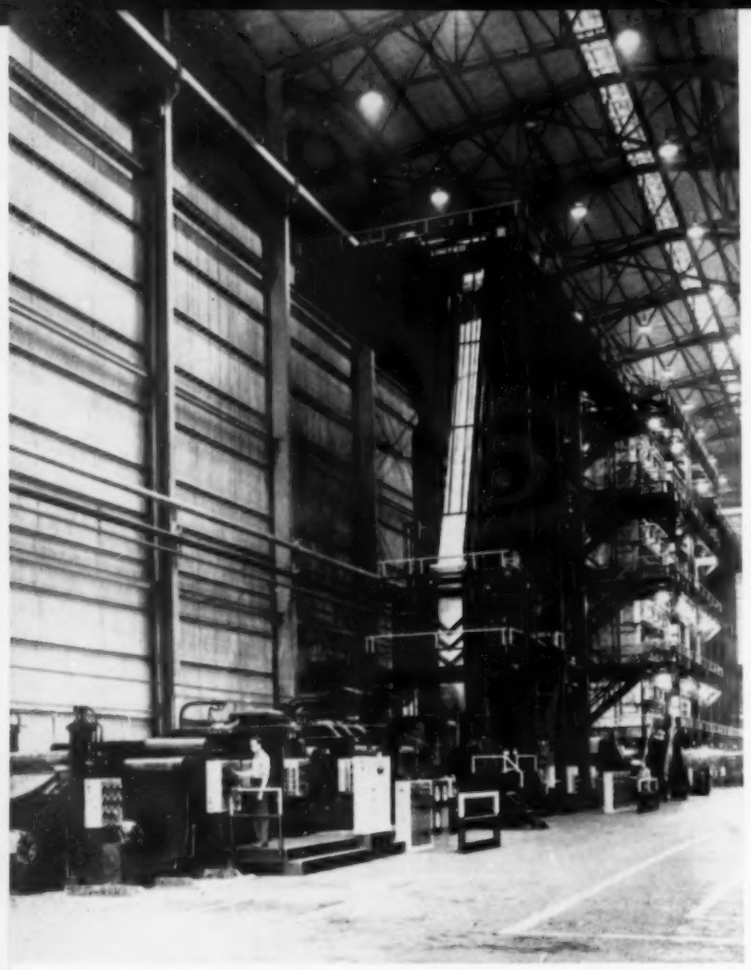


Figure 2 — Entry end of continuous annealing line at Gary Sheet and Tin Div. of U. S. Steel.

uncoilers are equipped with duplicate control and back tension regulating equipment. Automatic sequencing positions the leading strip in the welder once the tail end has been cut by the shear. The control systems provide semi-automatic sequencing of the entire welding operation.

With existing 1000-fpm continuous annealing lines, it is necessary to allow at least 30 or 35 sec for making a weld, including related shearing, handling, etc. A large percentage of welds can be made faster as there is a considerable amount of automation involved in the process. However, storage must be provided for the occasional unfavorable condition. Emergency stopping of the line results in a considerable scrap loss as well as time lost. Some experts on these lines believe that the entry storage looper should provide enough storage to run the line at full speed for one minute. There is a division of opinion in the industry relative to the possibility of shortening the time cycle at the welder. Some think that additional automation of the process will successfully reduce the time cycle. Others think that the additional mechanical "gimmicks" required for this automation will themselves provide a source of additional lost time in case of cobbles or misoperation.

It should also be recognized, that this weld is more difficult to make than similar welds made on continuous tinning lines because the strip is very hard after cold rolling and is dirty from the rolling lubricants. After a weld is made, the operator must take time to apply tension to check the weld before releasing it. A bad weld will sometimes break in the cleaning section, which is bad enough in itself, but if it breaks in the furnace it results in about eight hours down time.

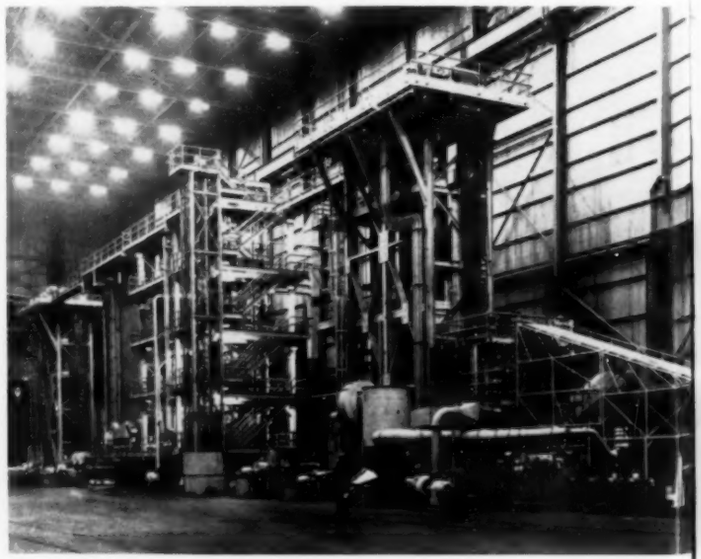
Included in the entry section is an electrolytic cleaning unit. The cleaning is done by passing the strip through an alkaline solution and the process is speeded up by electrolytic action. Following this, the strip is scrubbed by rotating brushes, passed through a hot water spray, a wringer roll, and finally dried by a hot air blast.

The storage device shown in the schematic is of the looper tower or tight loop type. This scheme will enable the loops to empty out evenly by hanging a counter weight from the bottom rolls. The trend today is to use this type of storage for the higher speed lines instead of the free hanging loops. A view showing a free hanging storage section is shown in Figure 3.

Free hanging loops have an advantage over the tight loops, in that no appreciable amount of tension is transmitted from one line section to another, and the strip can be guided from these loops. But the tight looper, in general, provides more storage capacity in a given space. Also the electrical control problem is simplified if the loopers do not require helper drives. If it is found that the transmission of tension variations through the tight looper becomes a problem, it may be necessary to add one free hanging loop to the system. To facilitate threading of the tight looper, an a-c drive motor is used to raise the lower rolls to line up with the upper rolls. One imaginative designer even provided for raising the lower rolls above the upper rolls.

In the case of the free hanging looper, it is necessary to provide intermediate pinch roll drives to help move the strip. The pinch rolls are located on the top of the tower between the free hanging loops and are each driven by motor with a separate generator. Each loop is controlled by a modulated loop control. On two earlier installations the control was provided so that during normal running conditions, the pinch rolls are speed matched to the furnace by applying the furnace and entry voltages as references to the pinch roll generator, with the separate loop controls acting as verniers. When a coil is changed the loop control is disconnected and the reference for the No. 1 loop

Figure 3 — Free hanging storage is used on this line.



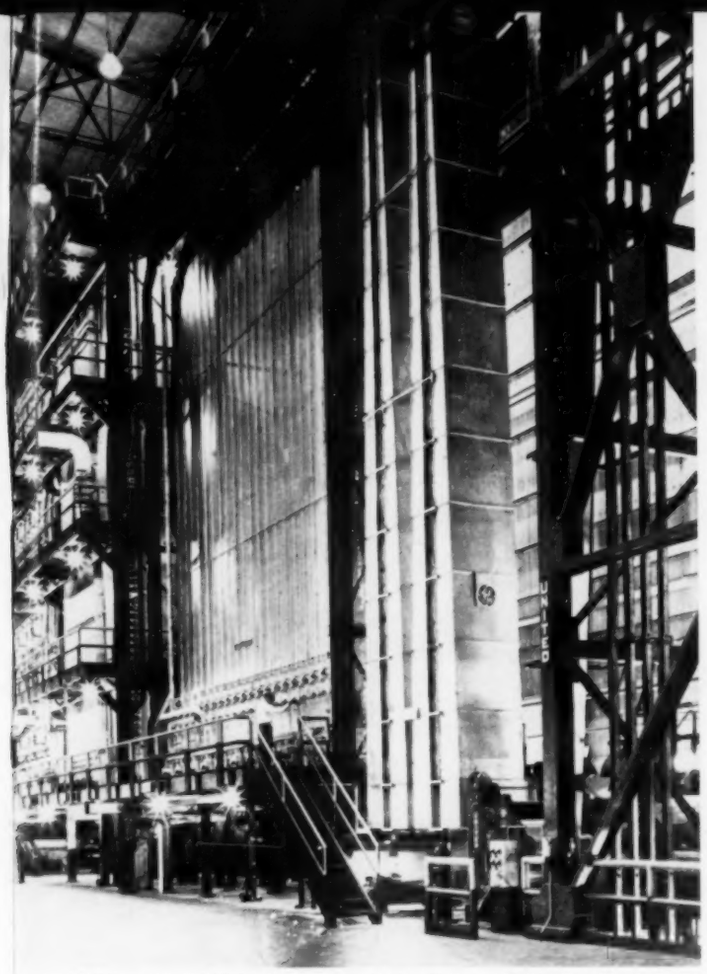


Figure 4 — Furnace on Gary Sheet and Tin line is heated by combination gas and electricity.

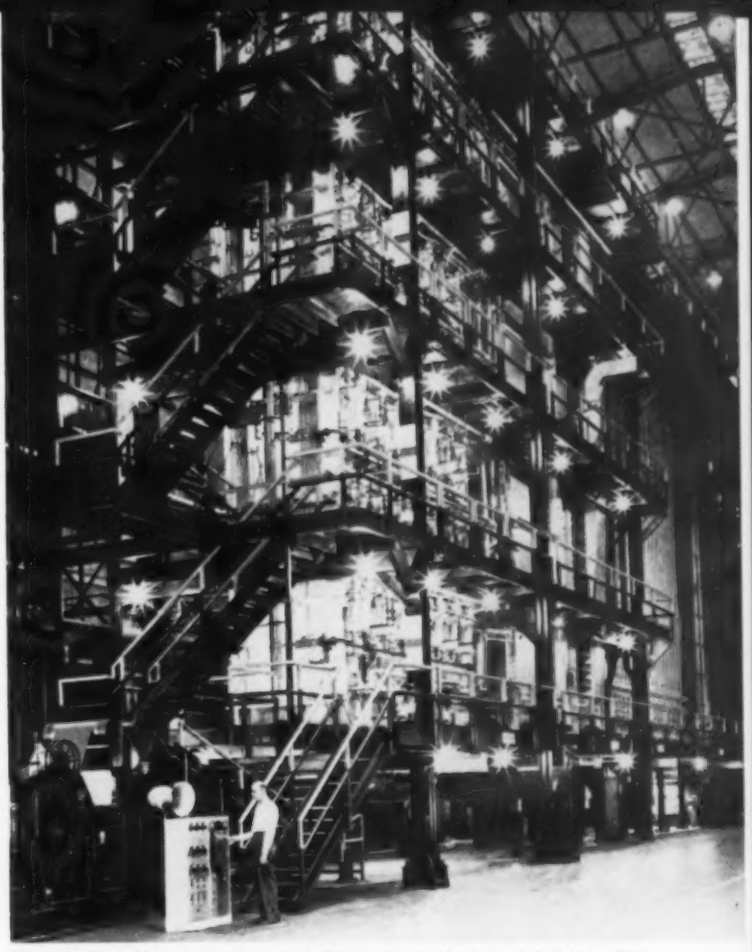


Figure 5 — Furnace is rated 30 tons per hour of 0.010 x 30-in. steel strip traveling at 1000 fpm.

becomes the average of the stopped section and the furnace voltage. This will cause the pinch rolls to run at speeds which will empty the loops evenly.

It was found on earlier installations, that the voltage regulator was quite difficult to adjust so it would evenly fill and empty the loops during acceleration and deceleration. On present installations of this type, the pinch rolls will be speed matched by using true speed regulators.

The lines now being put in service are not supplied with any helper drives on the tight loopers. On future 2000-fpm lines, opinions range from extremes of no helper drives, to helper drives on both stationary and movable rolls. We believe that either none or just stationary helper drives will be sufficient. Even with only the stationary rolls being driven, the problems of driving these rolls would be formidable. The control will have to be such that during normal running conditions, the 10 to 15 drive motors will have to be speed matched to the furnace section, and during acceleration or deceleration they will each have to run at a different speed.

In the tight looper a photo-electric limit switch loop control can be used, while a modulated loop control has to be applied for each free hanging loop. This is because of the much slower movement of the tight looper, on account of the larger number of strands.

As mentioned previously, if it is at all possible, the storage looper should have sufficient storage to provide time for reel changes, without slowing down the furnace section. A loss of tonnage is the obvious result of slowdown, but another factor must be considered. By slowing the strip through the furnace, say to half speed, the furnace atmosphere gases in the cooling chamber will drop in temperature quickly and the gases will contract. This tends to cause the furnace to suck in air at the entry end, which causes discoloration of the strip, and may build up oxide pimples on the rolls. To prevent this, provision must be made to add more furnace gas to the system during the slowed down period. This is not only an added expense but difficult to regulate properly.

FURNACE SECTION

Figure 4 is a view of a typical vertical furnace. This furnace is designed to produce 30 tons per hour with the strip 0.01 in. thick, 30 in. wide and rated at 1350 F. and 1000 fpm.

The furnace is heated by a combination of gas and electric heaters, and is divided into four zones or sections: (1) fast heating, (2) holding, (3) slow cooling, and (4) fast cooling.

In the first zone the strip is heated to a maximum temperature. A close-up view of this section is shown in Figure 5. The heaters are coke-oven gas fired, and the strip is heated by radiant "W"-shaped alloy tubes. To avoid possible contamination of the chamber, should one of the tubes develop a leak, an eductor system is used to draw the combustion products through the tubes keeping the tubes at a negative pressure. The incoming combustion air is preheated in this system in recuperators, where it takes heat from the exhaust gases. This materially reduces the amount of gas required. On the line illustrated, six passes are

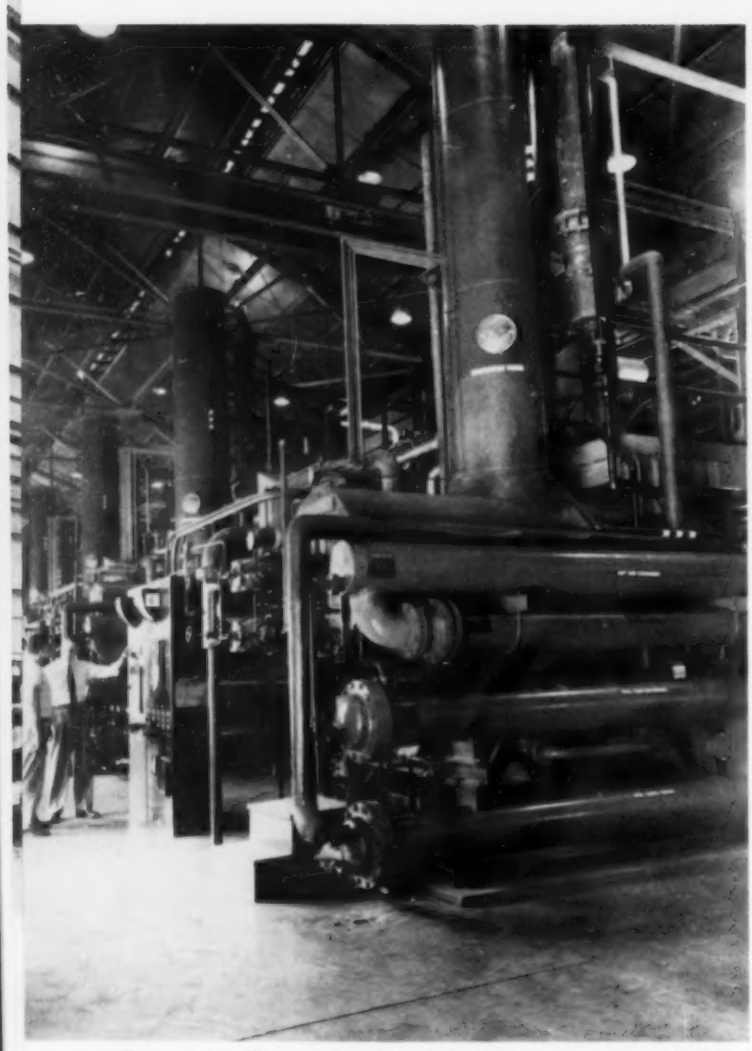


Figure 6 — Gas is produced by burning hydrogen fuel gas with air over a catalyst at medium to high air-gas ratios.

made in this chamber in 20 sec. On the future 2000-fpm lines, the number of passes would be increased to around ten. This time, or the number of passes, can be decreased if the maximum working temperature of the chamber can be increased. This is unlikely, since this temperature is limited by the danger of strip overheating during a stop, with possible breakage during restart. The practice is to maintain a differential of 400 F between the maximum working temperature of the chamber and the top temperature of the strip, with the top temperature of the chamber rated at 1800 F.

In the holding zone, the temperature of the strip is maintained to provide time for the necessary grain growth, or whatever happens to change the physical properties. On the illustrated line, the strip made six passes through this section in 15 seconds. The section is electrically heated by electric elements suspended from the furnace walls. Power consumption is very low due to the insulated walls of the furnace, except for a short period when starting up cold.

Two passes are made in the slow cooling zone in the illustrated 1000-fpm line and cooled to 900 F in five seconds. This zone is equipped with electric heaters and cooling tubes. The time required for this part of the annealing cycle has shown wide variations on

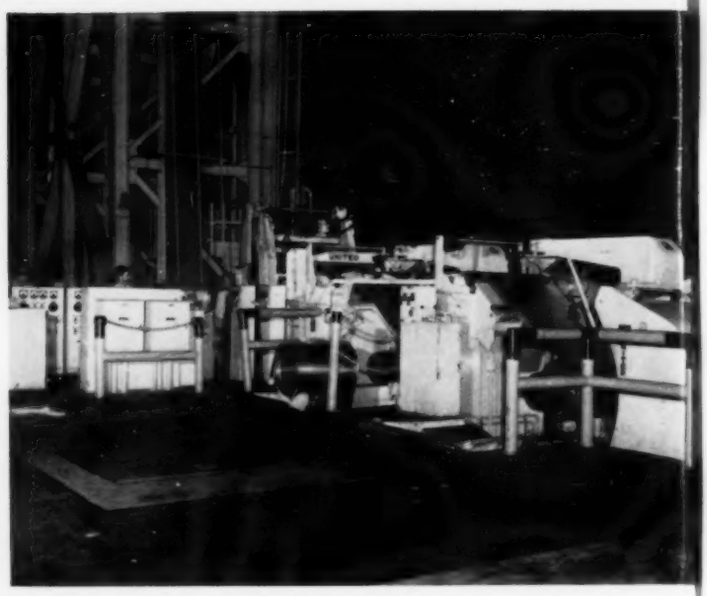


Figure 7 — Delivery section consists of two expanding mandrels with gate, belt wrappers, shear and pinch rolls.

present installations, and in all probability will continue to do so until experience determines the optimum time for different metallurgical results. It should be remembered that the line must handle several grades of steel and the optimum cycles may differ for each.

The fast cooling section is the final step in the annealing operation, in which the strip is cooled to the final temperature. This presents quite a problem since the heat is to radiate from a bright strip to a dull cooling surface. The thinking today is to cool the strip at the higher temperatures by passing it through a water-jacketed chamber or equivalent cold water pipes. At a lower temperature, say 600 F, the strip may be quenched which results in a considerable saving in time and equipment.

The success of water quenching as the final step in cooling is still being debated in some quarters. However, at least one of the newer lines now in operation is using it with some success, and several lines now on order are being designed with water quenching. On a 2000-fpm line, the use of water quenching will result in appreciable shortening of the line. The strip should be down to about 125 F when it emerges from the final cooling zone. This has been found quite difficult to achieve without the use of water quenching. Too high a delivery temperature may damage the rubber covered bridle rolls, pick up rubber smudges which will interfere with the tinning operation, and it may make it necessary to delay temper rolling until the coil has cooled.

During the operation of an earlier line, one of the major problems was tracking of the strip. Many things were tried, such as variations in tension, but nothing seemed very effective until they obtained the proper shape on the rolls in the furnace area. Once the proper shape was obtained on the rolls, and with the addition of one self-aligning roller on the entry side of the furnace, the serious tracking problems quickly disappeared.(5) The proper shaping of the rolls is carried all the way through the continuous section of the line including the bridles, etc.

Another problem which was experienced on this

line was that on starting up after an extended shutdown, the strip would weave and wrinkle very badly through the furnace holding and cooling section, often resulting in strip breakage. Many things were tried to correct this, and it was finally determined that the basic cause was that the rolls in the later sections of the furnaces were still cold and were chilling the strip too fast. The remedy which apparently corrected this trouble, was to accelerate the line very slowly after an extended shut down. When this was tried, the trouble disappeared.

The present protective atmosphere in all the furnace zones is a gas consisting principally of nitrogen with 3 to 6 per cent hydrogen with water vapor removed. Figure 6 shows the gas producers.

This gas is made by burning a hydrocarbon fuel gas with air over a catalyst at medium to high air-gas ratios. The gas is then passed through a liquid absorbent to remove the CO_2. Following this, it is passed over a catalyst in the presence of steam, causing a reaction which converts the CO to CO_2. Then the CO_2 is again removed as well as the moisture.

A small amount of hydrogen in the furnace gas is desirable to reduce any small amount of oxide which may be present on the steel. The amount of hydrogen should be limited to a percentage which is safe from explosion hazards in case appreciable quantities of air are sucked into the furnace. There are two reasons why it is desirable to remove the CO as well as CO_2 from the furnace atmosphere. First CO is reported to have a bad effect on the corrosion resistant quality of the product, and in some cases it has also produced some very undesirable effects on the bricks in the furnaces at around 900 C.

DELIVERY SECTION

The delivery section of the line consists of two expanding mandrels with gate, belt wrapper, shear and pinch rolls. The strip is usually threaded on the fly to decrease the time needed to change reels. Some equipments can shear and thread the empty reel at 400 fpm. This equipment is shown in Figure 7.

Storage facilities are similar to that on the entry end, except the loops are empty during normal running conditions and are filled when the delivery end is stopped during reel changes. Most lines have the same amount of storage capacity on the delivery end as on the entry end, although it is recognized that less storage is needed. On future high speed lines, it is likely that smaller loop storage equipment will be used for the delivery end looper.

ELECTRICAL DRIVE SYSTEM

As in most processing lines, the two major requirements for the annealing line electric drive are precise speed and tension control, to provide for a smooth movement of strip through the line. In the entry section, the tension must be regulated and maintained through the cleaning process. Control of tension through the process section is more important. At the annealing temperature, the tensile strength of the strip is greatly reduced, yet a uniform tension is required. The metallurgical characteristics are also affected by the speed through the furnace section. Finally, the strip has to be rewound with regulated tension to produce a good finished coil.

SPEED MATCHING AND CONTROL

Speed of the entire line is set by the furnace section with the No. 3 bridle acting as the pacer. The whole line is accelerated or decelerated by remote control of a master motor-operated rheostat. The operator is able to obtain precise speed control with a preset speed control which is capable of changing the speed of the line within one button out of 120 buttons of the motor operated rheostat. The furnace section is regulated by a speed regulator which is capable of holding speed variations to 1 per cent at top speeds.

The entry and delivery ends are roughly speed matched to the furnace section. Vernier speed control of these sections are under control of the loop controls in the loop storage units. About 25 per cent excess speed is provided in the end sections of the line to enable the loopers to be filled or emptied in a reasonable time. This overspeed must be sufficient to fill the entry storage looper even with the smallest size coil being processed.

ACCELERATION AND DECELERATION DURING REEL CHANGES

With total downtime during coil changes being so important, and since the acceleration and deceleration of the end sections are part of the down time, they must be made as short as possible. A rate regulator provides this by regulating the rate of rise or decay of generator voltage. This enables the reel drives to accelerate or decelerate in the fastest possible time and still be within machine commutating limits. The regulator has the advantage of fast response with built in "current limit" and provides constant acceleration allowing for easier speed matching.

TENSION CONTROL OF ENTRY AND DELIVERY SECTIONS

Tensions through the entry and delivery sections are produced between the reels and their bridles. The bridles are driven by individual motors and are load balanced by motor field rheostats.

The coil holders are driven by motors with sufficient field range to accommodate the build up ratio of the coil. Each of the motors is supplied with an individual booster generator. Suitable feedback regulating systems provide for constant tension in the strip, including inertia compensation for speed changes, and also keeps motor field adjusted to match requirements of changing coil diameter.

TENSION THROUGH FURNACE SECTION

Tension through the furnace section is produced between the No. 2 and No. 3 bridles. The motors for the No. 3 bridle are connected directly across the generator and are load balanced by motor field rheostats. The tension is set by a torque motor which acts

on a surge roll between the two bridles. The surge roll position is regulated by a modulated loop control which acts on the booster generator of the No. 2 bridle through a magnetic amplifier. One design of a 2000-fpm line has a surge roll at each end of the furnace section.

The functions of the helper roll drives located in the furnace are:

1. Jogging the strip for threading.
2. Inertia compensation during acceleration and deceleration.
3. Compensation for roll bearing friction.

The problem of maintaining the correct torque on the helper drives to prevent dangerous build up of tension or loss of tension is not easily solved. Even if the circuit is designed to regulate current in the helper motors, there is no guarantee that it is adjusted to regulate the right amount of current, since the current in this case is not a measure of tension. One method of doing this might be to provide strain gages under some of the roll bearing pillow blocks. It is possible, of course, to design a circuit where this regulation of strip tension could be automatic. However, it is questionable whether this additional complexity in the circuitry could be economically justified. Perhaps it would be sufficient if the operators could merely read approximate strip tension at a number of points and make manual adjustments on the helper roll drives in accordance with that information.

At present, the approach is to supply individual drive motors on each helper roll with a booster supplying IR compensation to each section of rolls. A speed regulated furnace section will tend to decrease any load changes on the helper drives during an operator's change in tension through the furnace section. Some speed droop is also very desirable. This can be obtained by load resistors or by cumulative series fields. The boosters in each section will provide the necessary amount of IR compensation to help in maintaining constant torque from the helper roll drives over a wide speed range by generator voltage.

BIBLIOGRAPHY

1. "Continuous Strip Annealing," by E. J. Seabold, 1946 Proceedings AISE.
2. "High Speed Continuous Annealing of Tinplate," by M. D. Stone and E. H. Randich, 1953 Proceedings AISE.
3. "Modern Tinplate Annealing," by A. C. Parson, Jr., and J. Soyring, 1954 Proceedings AIEE.
4. "Quality Comparison of Box vs. Strip Annealing of Tin Mill Products," by W. H. Swisshelm, 1955 Proceedings AISE.
5. "Continuous Annealing," by J. Soyring, 1955 Proceedings AISE.
6. "Continuous Annealing of Steel Strip—Electrical Drives," by E. B. Fitzgerald, 1956 Proceedings AISE.
7. "Continuous Annealing of Tin Plate Strip," by H. Drever, 1956 Proceedings AISE.

Tube Mill Practice

A selection of articles from the IRON AND STEEL ENGINEER on various phases of tubemaking.

Practical information on layout and operation of facilities for seamless, butt and electric weld pipe, a field in which little information has been published...23 articles by 20 authoritative writers ...invaluable for engineers, operators, trainees and students.

$8^1/_4 \times 11^1/_4$ in.,.....196 pages, illustrated, clothbound

Price: To AISE Members...$2.00

To Others.....$4.00

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building

Pittsburgh (22), Pa.

. . . . . new sintered oxide cutting tools are available in all sizes of standard blanks used for other cutting materials . . . . best results have been obtained with negative rakes and large lead angles, using mechanical holding . . . .

the Application of SINTERED OXIDE CUTTING TOOLS

By LOUIS M. DeMARCO, Stupakoff Division, The Carborundum Co., Latrobe, Pa.

▲ EVERYONE having commercial knowledge of metal-cutting has watched, been aware of, or has taken part in the evolution of cutting tools, the end purpose of which has been to help speed the production of articles for war or peace and make the world a better and safer place in which to live.

We are aware of the growth of carbon tool steels from their inception to the present highly developed state. We know of the development and growth of high speed steel and its impact on the welfare and well being of man by allowing two pieces to be machined where previously only one could be machined.

We have watched the advent of the cast alloys and tungsten carbide cutting tools and have noticed the tremendous advances they have been responsible for in the metal-working and other industries. The improvements have been great enough to be a significant factor in our present economic well being.

We are again growing in this regard, with the development of sintered oxide cutting tools. The extreme hardness and high strength obtainable in some light metal oxides early led to their consideration for applications requiring wear-resistance, smooth surfaces and precise manufacturing tolerances.

The success of these oxides in their initial applications soon led to an investigation of the possibility of their use in machining highly abrasive materials, and the development of tools made thereof. As greater toughness was incorporated into the experimental tools, it became feasible to cut not only non-metal, but also cast iron, carbon steels and alloy steels.

Aluminum oxide is hardly a new product and history shows that its properties for the purposes discussed in this paper were under investigation as early as 1905. We find that patents issued in 1912 described a sintered alumina for wear resisting and cutting tool applications.

Germany, England and Russia were the earliest and most active in these investigations and it seems that cutting tools made from this material were in occasional use in Europe since 1912.

Investigations of this type were conducted in the United States during the 1930's. In 1946, Mr. Semon H. Stupakoff was granted a patent, for a high alumina composition, based on work accomplished in 1939.

Some recent work on oxide cutting tools seems to be that conducted in the USSR in the years since 1948, and a fair amount of literature on the subject seems to have come to light recently. Their work with and results from a glass bonded aluminum oxide material, type TsM 332 designated "microlite" or "artificial super-strong stone," as they call it, seems to be the most notable. In their reports, phenomenal results are listed such as tool life of 43 hours maximum, with average tool life of 26 hours for microlite tools as against three to five hours for T15-K6 which appears to be a general purpose grade of tungsten carbide. Another report states that speed of 3200 meters per minute (approximately 9600 sfpm) were attained in metal machining with microlite cutters. Still another report deals with the establishment of maximum speeds for cast iron using the tungsten cobalt alloys. Success was claimed in raising the speed from 270 to 400 meters per minute (approximately 800 to 1200 sfpm), and above this speed the cutters "burned." However, starting at this point, with microlite cutters, it was possible to raise the speed to 1,000 meters per minute (approximately 3280 sfpm). The work piece was heavy, on the order of 175 kg (approximately 350 lb). They report the machining of chilled iron

rolls, 75 to 78 Shore hardness, at 80 meters per minute (approximately 240 sfpm) with microlite, as against 20 to 30 meters per minute with tungsten carbide. Still another report is the machining of cast iron at 3787 meters per minute (approximately 11,000 sfpm) with microlite, allowing for the completion of the job in 8 minutes which formerly required 4 hours.

Other Russian applications for microlite include its employment wherever it is necessary to have high resistance to wear, particularly at high temperatures. A matrix of microlite for the hot pressing of nonferrous metals is one application cited where tungsten carbide was replaced. Another application, replacing ruby, was a liner for a container handling abrasive materials. At a watch factory microlite inserts were employed for polishing axles of watch gears. Pressing molds and rolls in the production of items like rivets, the rolling of glass and other applications especially where high heating is involved in the molding process were also mentioned.

CURRENT DEVELOPMENTS

Many months of intensive research and testing with excellent cooperation from industry have resulted in a development by our company, of a high alumina sintered oxide material for cutting tools, which in its present form can machine both steel and cast iron at speeds far in excess of those commonly used today. Excellent work finishes are invariably produced.

The characteristics of this new material are as follows:

Hardness—At best a difficult thing to measure on this material. On the Moh's scale its hardness is between that of sapphire and diamond. Rockwell "A" hardness results indicate an average of 95.

Strength—Room temperature compressive strength averages 600,000 psi, while tensile strength averages 80,000 psi. However, this lower tensile strength is maintained at much higher temperatures than other cutting materials.

Thermal conductivity—Very poor compared with other tool materials. Consequently there is little or no heat built up in the tool or holder.

Electrical conductivity—For all practical purposes, it is a non-conductor of electricity and is non-magnetic.

Density—The density is just under 4 g per cc.

Chemical resistance—This quality is outstanding in that it resists not only ordinary acids, but also hydrofluoric acid and even strong alkaline solutions. Neither strongly oxidizing or strongly reducing atmospheres up to 3500 F will affect the chemical composition.

RESULTS OBTAINED

Alloy Steel

High carbon-high chrome bar stock has been turned on a finishing operation in a steel mill. On separate cuts, speeds of 400 to 600 and 800 sfpm were used with depths of cuts from 0.125 down to 0.015 in. Feed rates of 0.010 to 0.020 to 0.030 in. per revolution were used on bars 12 feet long with favorable results.

SAE 6145 hot rolled annealed bar stock has been machined in an automotive plant at 1250 sfpm (machine capacity) 0.020 in. feed per revolution, 0.100 depth of cut—without coolant, with good tool performance. The same material except heat treated to Rc 32, was machined under exactly the same conditions with equally good tool performance.

AMS 6382 heat treated to Rc 37 has been machined in an aircraft plant at 535 sfpm—0.008 in. per revolution feed tapering cut from $\frac{1}{4}$ to $\frac{1}{8}$ in. depth. This stock removal left a partial wall thickness of $\frac{1}{16}$ in. which was totally unsupported. Increased fixture rigidity would very likely result in higher speeds being used. At this speed, however, no distortion of the work piece occurred. No coolant was used.

SAE 3145 Rc 28 to 32 has been machined in a toolmaker's plant at surface speeds from 600 to 1050 fpm with depths of cut from 0.050 to 0.125 in. and feeds from 0.008 to 0.030. No coolant used.

SAE 4340 Rc 48 to 52 has been machined in an aircraft gas turbine plant at speeds of 600 to 800 and 1000 sfpm with feeds of 0.008 to 0.020 and depths of cut to 0.125 in. At 1000 sfpm and 0.008 feed, the chip produced was extremely difficult to control, rising almost vertically from the top of the insert with a chip breaker width of $\frac{1}{16}$ in. At 800 sfpm and 0.010 feed, chip control was satisfactory but indications were that tool life might not be satisfactory. The best results were obtained at 600 sfpm, 0.012 feed, and 0.100 in. depth of cut. No coolant used. A small amount of heat developed in the workpiece with the first cut and successive cuts built up more heat, but after several cuts the piece was not so hot that the bare hand could not be placed on it. Heat build-up in the tool holder was very slow and was probably caused mainly by contact with hot chips. Total heat in insert and holder was considerably less than that of the workpiece.

Super-Alloy

A heat treatable super-alloy of the titanium group has been machined. It had a Brinnell hardness of 262 to 341 and a partial analysis of 20 per cent Cr, 76 Ni, 2.3 Ti. Cutting time was reduced from 40 minutes to 4 minutes compared with previous tool material used. Depth of cut was increased from 0.005 to 0.125 in. and the need for 250 separate tool changes and grinds was eliminated. No coolant used.

High Speed Steel

M-2 high speed steel hot rolled annealed bar stock has been machined at 505 sfpm (machine capacity), 0.023 in. feed per revolution, 0.100 in. depth of cut—without coolant. Cuts were varied to a low speed of 250 sfpm and to a low feed rate of 0.005 and various depths of cut down to 0.005 in. The first cut involved scale and eccentricity of the bar. The bright blue color of the chip indicated a lesser heat condition than would be expected under these conditions. While the speed capacity of the machine had been reached, the indication was that the tool would have performed as well at higher speeds.

Carbon Steel

SAE 1035 and SAE 1045 annealed bar stock have

been machined at speeds up to 1300 sfpm, 0.025 in. feed per revolution and 0.187 in. depth of cut. Machine capacities under these conditions are easily reached and a typical case illustrates this point as well as the easy cutting qualities of this tool material. In this case, calculations indicated that 27 hp was required. The cutting was accomplished on a machine having a single motor of 10 hp and cuts were continuous, each being approximately 24 in. long.

Cast Iron

Meehanite iron, both ordinary and spot chilled, nodular iron and spherodized perlitic malleable iron have all been machined at speeds up to 1250 sfpm. (Spindle speed has been the limiting factor in each case.) Feed rates were up to 0.020 and depths of cut up to ¼ in. All cutting was done without coolant and there was little or no heat generated in the work piece or tool. Chip temperatures appeared to be less than when conventional tools were used at much lower rates of stock removal.

Plastics

A plastics manufacturer, forced to use diamond cutting tools to machine a glass filled phenolic material, reports the initial use promises to reduce his tool costs substantially.

REQUIREMENTS FOR USE

The same type of requirements that accompanied other improvements in cutting tools is called for here, but some are more, while others are less important. It is generally understood that high velocity turning requires:

1. Rigid machine tool and workpiece.
2. Adequate coolant.
3. Controlled microstructure.
4. Proper grades of cutting tool material.
5. Correct feed rates.

With these tools, the first or rigidity factor is of the utmost importance and cannot be overstressed. Coolant appears to be non-critical with excellent results obtained cutting dry. Controlled microstructure of the workpiece will no doubt be very important when upper speed limits are approached, and will result in maximum speeds for certain conditions of structure. However, it seems now that a single grade will come very close to satisfying the requirements for cutting all types of steel, cast iron, non-ferrous metals, nonmetallics and plastics. Feed rates must be selected to give the surface finish required, and if this is unimportant and rapid stock removal is the only consideration, rigidity, power and tool size are the factors to be considered.

Much of the older machine tool equipment now in use possibly will not be adequate to take full advantage of this new tooling, however, a great deal of the more modern equipment can be used more advantageously than is the case at present. Also, recent history has shown that machine tool builders are quick to rise to the occasion when cutting tools demand faster, more powerful, more rigid machines. Automatic or semi-automatic accessories make shorter cutting time cycles desirable, as do improved materials handling equipment.

SUMMARY

For cutting tool applications, the material is available in all sizes of standard blanks presently used in other cutting materials. So far, best results have been obtained with negative rakes and large lead angles, utilizing mechanical holding provisions. Research is being conducted on other techniques of holding, including metallizing for brazing, and the use of epoxy resin cements. Indications are that the throwaway type of indexable insert will be used to great advantage.

To the production engineer, the use of these tools offers higher rates of production at lower costs. This is accomplished primarily by the higher speeds at conventional feeds and depths of cut, resulting in a larger volume of material removed, and less down time on expensive machinery. Other benefits are the greater ease of machining, better finishes than are now obtained, and less part distortion (therefore fewer rejections), because of less heat generated in the cutting operation.

The application is by no means limited to light finishing cuts. It has successfully machined alloy steels at depths of cut to 0.4375, feed rates to 0.040 in. per revolution and speeds up to 2000 sfpm. On castings and forgings, good results have been obtained in cutting through scale conditions. Entrance cuts involving eccentricity of the part to be machined have likewise been accomplished.

In addition to the cutting tool potential, it holds great promise for use in a wide variety of wear applications. All types of gages, high-temperature antifriction bearings, surface plates, extrusion and drawing dies, plungers and pistons, sand blast and spray nozzles, thread guides, centerless grinding rests and laboratory crucibles are but few of the possible uses for this high-strength oxide material.

Probably the most significant aspect of the development of these new oxide cutting tools is the coincidence of their introduction at a time when industry is making new and increased demands for hard cutting materials. Today's industrial equipment is rapidly reaching a high degree of automation; research has given us new and often difficult materials to machine; method engineers are looking for more and better ways to cut costs while increasing production; and all these phases of industrial activity present a serious challenge to the maker of cutting materials. Oxide tools meet this challenge! They have already resulted in previously unheard-of machining rates, ease of machining and quality of finished product. What is more, they offer a new challenge of their own: few present-day machines are capable of realizing fullest benefits of oxide-tools, none have stretched the uses of the material to its limits. These tools themselves promise a new revolution in machine design, power and equipment. This revolution will ultimately benefit all of industry by taking it to new horizons of quality and productivity.

DISCUSSION

PRESENTED BY

RICHARD GILLON, Tool Engineer, Bethlehem Steel Co., Sparrows Point, Md.

LOUIS M. DEMARCO, Supakoff Div., The Carborundum Co., Latrobe, Pa.

M. D. STONE, Manager, Research & Development, United Engineering and Foundry Co., Pittsburgh, Pa.

N. A. WILSON, Manager of Research Dept., Morgan Construction Co., Worcester, Mass.

H. R. KNUST, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.

H. J. LEAVER, Works Manager, Treadwell Engineering Co., Easton, Pa.

Richard Gillon: How does the cost of aluminum oxide compare with high speed steel and carbide tools?

Louis M. DeMarco: At the present rate of production in our plant we are approximately double the carbide price.

Richard Gillon: How does this cost compare, on the basis of cubic inches of metal removed per minute or per hour?

Louis M. DeMarco: We have no comparison because there is no metal on the market that will machine as fast as these new oxide cutting materials, so we cannot compare it. If we are running at carbide speeds, we say we will give you double or triple the life at carbide speeds, but when we are running beyond carbide speeds, or ten times faster than carbide, if we take one pass, we have out-performed carbide.

Richard Gillon: I notice that in your paper most of the depths of cuts and feeds were what we would normally term as relatively light in the steel industry. Is there any possibility that any aluminum oxides could be developed to take heavier feeds and depths of cut?

Louis M. DeMarco: We are running a profiling job in Cleveland where we are starting at a depth of cut of $\frac{7}{16}$ in., 1089 fpm, and we finish out taking off 0.300 in. at the end of the cut, 24 in. long.

M. D. Stone: I gathered from the talk that you apparently are stressing the desirability or necessity of machining at high speeds. Now when you have a given machine tool, say, a lathe driven by a 50-hp motor, in general you will cut up to the capacity of the motor whether you take highspeed light cuts or lowspeed heavy cuts. For instance, at an average figure of about one horsepower per cu in. per min. removed, if you are utilizing your full horsepower, let us say, you will be able to remove 50 cu in. per min of a given material.

Now, why is it particularly advantageous to do that at highspeed and light cuts as compared to heavy cuts at lowspeed? Or, more specifically, if an existing machine is limited in its surface speed per minute, why is that necessarily a limitation on the tool? All we would do for high speed steel tools, for instance, is to reduce the speed, increase the feed and still utilize the 50 hp.

Louis M. DeMarco: One thing you do in running at high speed is to cut down your heat, in cutting heat you cut friction. If you cut friction and cut heat it adds up to cutting horsepower. We can remove more metal at 2,000 fpm than you can at 250 fpm using your feed of 0.025 or 0.035 with less horsepower.

M. D. Stone: If you will examine some of the published ASME metal cutting data, I think you will find, and I think you will be surprised to find, that generally the efficiency of cutting as measured by hp-hr that will remove a certain amount of material is better at lowspeed and heavy cuts than at high speed and light cuts.

You usually take less power per cu in. of metal removed at slow speeds taking heavy cuts than you do at high speeds taking light cuts. That is not a function of the tool, it is a function of the way metals behave, apparently. That is why I am asking the question.

Louis M. DeMarco: Let us take two tools: one that creates pressure, and we will run at slow speeds. We will take one tool at 10 degrees negative, and we will take another tool at 10 degrees positive. The 10 degree positive tool will give you a freer cut. The 10 degree negative will give you more pressure, it will plough the material off, so to speak.

Now, at 250 fpm those lines are far apart on horsepower, pressure. At 1250 fpm, those lines become tangent, so it requires as much horsepower. You are gaining horsepower as you go up in speed if you can reduce heat. The greatest builder in horsepower is heat, because your material is welding to that tool point, and as that material welds you increase your horsepower. That is why, if you can run at high velocity speeds, you will reduce horsepower. It is hard to believe, but it will chart that way.

N. A. Wilson: Have you had any difficulty in machining material in which the carbon content, for example, changes from 0.90 to 0.15 carbon within $\frac{1}{8}$ in. as exist in case carburized parts?

Louis M. DeMarco: No. Say we are machining material up to 69 Rockwell C. We can take a hardened broach after heat treat and take a slice across the teeth. We can take your softer grades of carbide, and I am talking about your high cobalt grades, and we can cut them.

H. R. Knust: How do you "dress" these tools?

Louis M. DeMarco: We can grind these tools easier, faster with diamond wheels than you can any other cutting material of its hardness, the reason being that it is aluminum oxide, it keeps your diamond wheel cutting freer. We removed 0.300 in. from an insert and measured the wheel wear and there was absolutely no wear to the diamond wheel, and the wheel was welded when we started. We had taken some grinds or were grinding on other material and the metal bonded wheel, with which it is hard to grind carbide as it actually loads the wheel, and we stopped grinding with a loaded wheel and our material actually cleared the wheel for us.

H. J. Leaver: Has there been any experience using this material for intermittent cuts on material in the range of from 55 to 60 Rockwell C?

Louis M. DeMarco: You cannot machine intermittent cuts where you have an impact blow on material that is hard.

Design and Operation of a BLAST FURNACE WITH A CARBON BOSH LINING

By E. K. MILLER, JR.

Assistant Division Superintendent, Blast Furnaces, Gary Steel Works, United States Steel Corp., Gary, Ind.

. . . . experience with carbon lined bosh shows smoother furnace operation, less cooler trouble, larger working volume and lower fuel rates . . . . these advantages more than offset high costs of carbon bosh . . . .

▲ THE use of carbon as a blast furnace refractory is certainly not new. As a matter of record, it has been reported that carbon was used in blast furnace refractories as long ago as the year 1900. However, in all this time the real value of carbon as a blast furnace refractory has never been thoroughly explored.

In hearths and in hearth walls carbon refractories have been used quite successfully; however, in the portion of the furnace above the hearth, the blast furnace operators in this country have been hesitant about experimenting with carbon.

In their paper on the "Evolution of the All-Carbon Blast Furnace," Chesters, Elliott and Mackenzie mention that excellent results were obtained from two 17-ft furnaces in which carbon bosh linings were installed in 1945. However, in their enthusiasm about the use of carbon refractories, they decided to extend the carbon lining to the top of the stack, and in 1949 they blew in the first all carbon lined furnace at Appleby-Frodingham. In 1953 the first full scale experiment in this country with carbon above the hearth wall was undertaken when Gary Works No. 10 furnace was blown in with a carbon lining extending from the bottom of the stave coolers to 35 ft above the mantle. The design and construction of this furnace was described by Stapleton and Debenham and its operation was described by J. M. Walsh.

Because the campaign of this carbon lined Gary furnace indicated that it might not be feasible to use carbon refractories in the blast furnace stack, the furnace was relined with carbon extending only from the bottom of the staves to the mantle. Above the mantle regular ceramic refractories were used. This furnace has now been in operation for more than a year and a half and from its excellent performance many conclusions can be made concerning the use of carbon in the bosh section of the blast furnace.

BOSH CONSTRUCTION

Although on the previous campaign the Gary No. 10 blast furnace bosh had been lined with 9-in. and 13½-in. petroleum coke carbon bricks laid alternately for a wall thickness of 22½ in., the bosh of the present installation is lined with 15-in. long carbon blocks. These blocks are especially designed key shapes and extend from the hot face to the bosh shell. Anthracite coke base bricks are used in the region from the cinder notch to the mantle, and petroleum coke base bricks are used below the cinder notch. Figures 1 and 2 show the arrangement of the carbon bosh lining.

BOSH COOLING

The bosh is enclosed in a shell of heavy steel plates welded together to form an air tight casing. Vertical steel cooling channels extending from the bend line of the bosh to the mantle are welded at close intervals to the bosh casing. Figure 3 illustrates the construction of the bosh cooling channels and Figure 4 shows the actual installation. The water enters the bottom of the channels and is withdrawn from the top. Sediment traps are incorporated in the design of these channels.

This type of cooling has many advantages compared to the conventional shower type of cooling used on most

European carbon lined furnaces. In particular, it eliminates the occurrence of water messes that are to be expected with shower cooling. The effectiveness of this type of cooling is illustrated by Figure 5 which shows the bosh shell temperatures at the cooling channel level and also above the cooling channels. At the cooling channel level the temperature has not exceeded 250 F and at the higher level it has not exceeded 350 F.

Figure 1 — Section through No. 10 blast furnace at Gary. Solid black shows carbon lining.

ADVANTAGES OF THE CARBON LINED BOSH

In the operation of Gary No. 10 furnace with a carbon lined bosh, many benefits have been obtained that can be attributed specifically to this particular type of construction. These benefits are best illustrated by comparing the performance of the carbon bosh furnace. Several of these advantages are as follows:

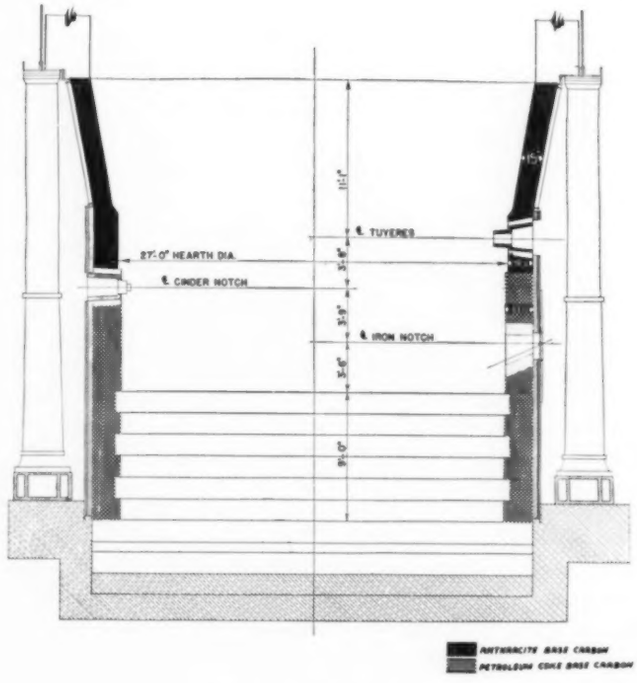
1. Smoother furnace operation—With the carbon bosh furnace it has been observed that the tuyeres work more evenly and that there is less of a tendency to lime up than there is with a conventional furnace. As a result, it has been possible to keep the maximum wind rate on the furnace most of the time. Over the past 18 months, No. 10 furnace has averaged 5 per cent more wind per cubic foot of working volume than the average of the three other Gary furnaces of comparable size.

2. Elimination of cooler trouble—Because there are no bosh coolers in the furnace, there is no danger of burning them. Even if there is a failure in the water supply, there is not much danger of injuring the bosh as long as the wind is taken off the furnace. For this reason the downtime that is encountered on a conventional furnace for changing bosh coolers is entirely eliminated.

3. Large working volume—Because the bosh lining is not as thick in this furnace as in a conventional furnace (15 in. as compared to 27 in.), this furnace has a larger working volume than that of a conventional furnace of the same general dimensions. This is one reason it is possible to use higher wind rates in this furnace without incurring a corresponding increase in coke rate.

4. Savings in fuel—Probably the most important advantage of the carbon bosh lining is the savings in fuel that it appears to have effected. In the past it has been difficult to make a satisfactory determination of the fuel savings that have resulted from a change in

Figure 2 — Section through bosh and hearth gives lining details.



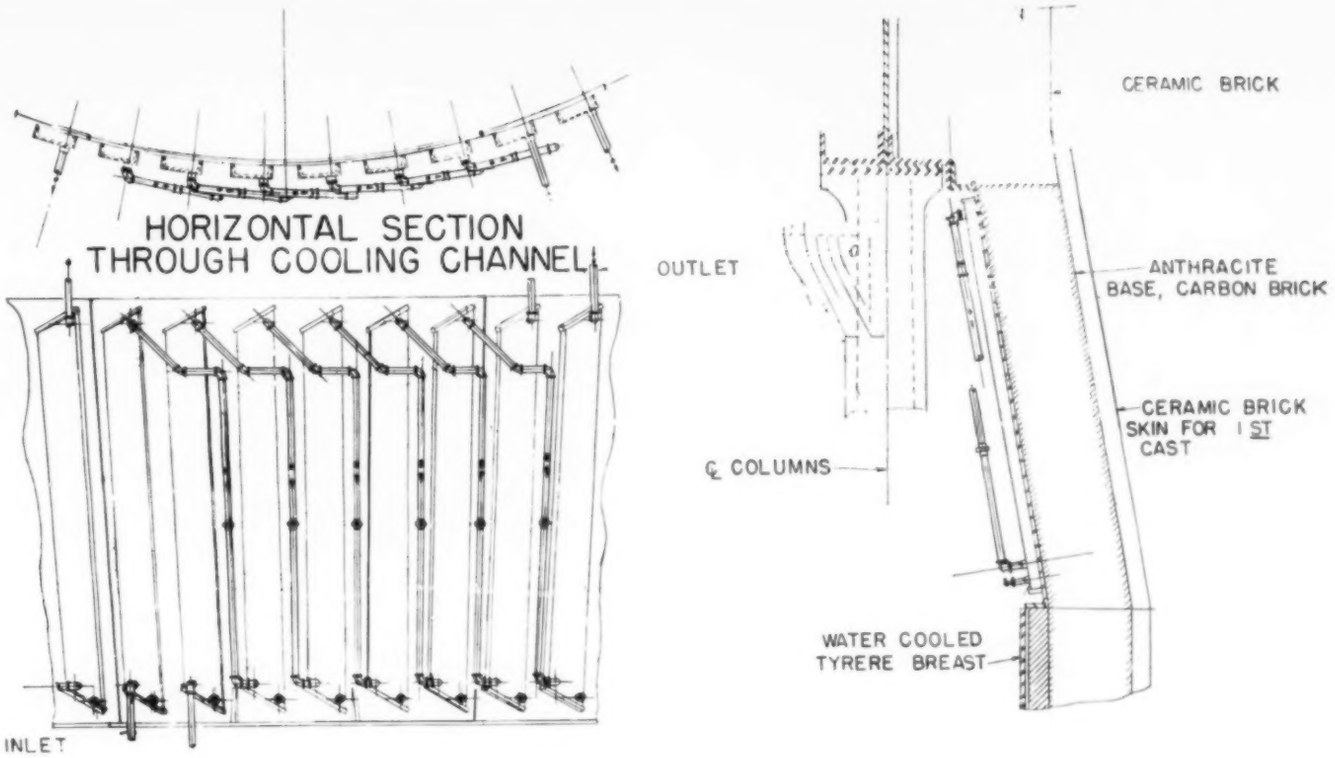


Figure 3 — On left is typical elevation of bosh cooling channels and on right is section through cooling channels and brickwork.

furnace design. The reason for this was that very often with changes in design, there have been changes in burden materials or changes in operating conditions that have interfered with the appraisal of the design changes. A method has now been developed, however, by R. V. Flint of the United States Steel Corp., Industrial Engineering Div., for evaluating the effects of different burdening and operating variables. Consequently, by taking into account the effects of differences in burden materials and differences in operating practice, two furnaces can be compared on an equitable basis. In this way a comparison can be made that is independent of the chemical composition of the coke, the type of burden material, the hot blast temperature, the wind rate, etc. In making a comparison of this type between two furnaces, it is convenient to express the fuel rate in terms of pounds of effective carbon per ton of hot metal. Effective carbon is defined as the portion of the ultimate carbon in coke, which is available for performing outside work, e.g., smelting the burden. (For example, with coke of the composition now being used at Gary, one pound of effective carbon is equivalent to approximately 1.33 pounds of coke.)

A comparison of the fuel rate obtained on Gary No. 10 during its carbon bosh campaign with the fuel rate obtained during its 1948 campaign in which it had a conventional ceramic bosh (after adjusting the fuel rate for the effects of variables in burden materials and variables in operating practice) shows a substantial fuel savings in favor of the carbon lined bosh. However, because the working volume of this furnace was enlarged considerably when it was rebuilt, it is possible that a large portion of the apparent fuel savings was caused by the change in the shape of the furnace and not entirely by the carbon bosh. Consequently, a more accurate appraisal of the carbon bosh can be made by comparing its performance with the average performance of all of the Gary furnaces with conventional boshes. This comparison shows a savings of about 35 pounds of effective carbon per ton of hot metal in favor of the carbon bosh furnace. Furthermore, the other United States Steel Corp.'s furnace that was lined with a carbon bosh a little more than a year ago shows a similar improvement, 24 pounds of effective carbon per ton of hot metal for the carbon lined bosh as compared to the conventional bosh. In this furnace, however, no changes were made in the furnace lines when the carbon bosh was installed.

Although it was expected that the smoother operation of the carbon bosh furnace would result in more efficient furnace performance, it was not apparent at first that the fuel rate for this furnace would be appreciably lower than that of a conventional furnace, because it was believed that the high thermal conductivity of the carbon bosh lining would cause an excessive loss of heat from that region of the furnace. However, a calculation of the heat loss through the bosh (using the thermal conductivity data from Chesters, Elliott and Mackenzie, 24 Btu per sq ft per hr per degree F per in. and assuming an inside bosh temperature of 2500 F) showed that it should be only about 65 Btu per sq ft per min. This is equivalent to about 52,000 Btu per ton of hot metal or about 13 pounds of equivalent carbon per ton of hot metal.

Because there was no simple method for calculating the heat losses through a conventional ceramic bosh with embedded cooler plates, tests were conducted to determine the relative heat losses through both a car-

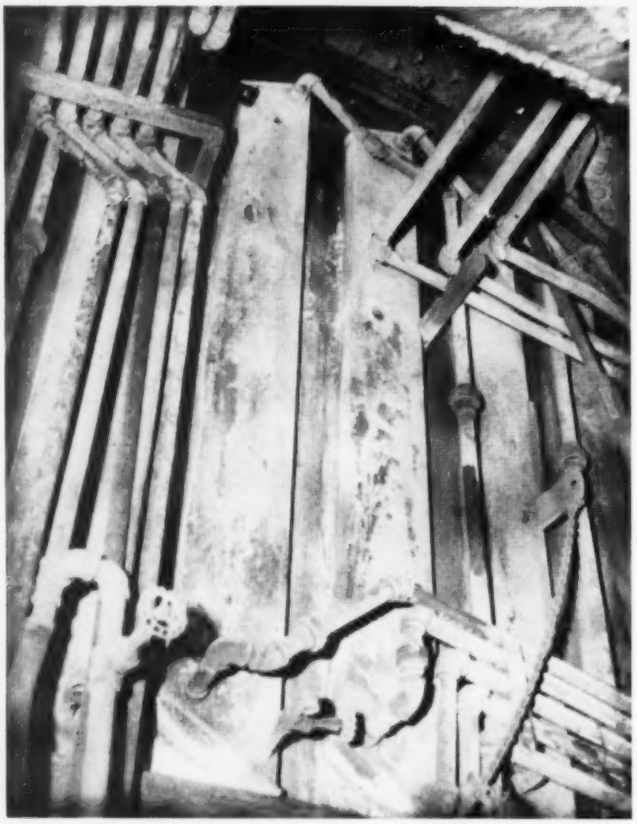


Figure 4 — Water enters bottom of channels and is withdrawn from top.

bon lined bosh and through a conventional type bosh. For this comparison, the Gary No. 7 furnace was selected because its bosh is quite similar in size to that of No. 10 and because it is a relatively new furnace. A check run was also made on No. 4 which is a 28 ft-3 in. hearth diameter furnace.

In these tests the flow of water and the increase in water temperature was measured at each cooler. Contrary to our original belief, the results of these tests, listed in Table I show that the heat loss through the carbon bosh is as low if not even lower than the loss through the conventional bosh.

SUMMARY

As a result of the experience to date with the carbon lined bosh in Gary No. 10 blast furnace, it appears that it is reasonable to expect smoother furnace operation, less trouble with coolers, a larger working volume and a lower fuel rate with a carbon bosh than with a conventional type bosh. These advantages should more than offset the higher initial cost of the carbon bosh lining.

Figure 5 — Measured bosh shell temperatures.

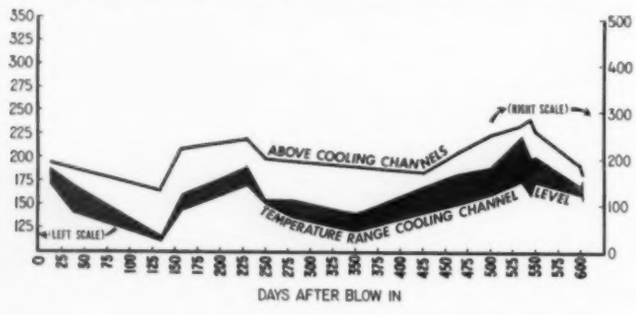


TABLE I

Results of Heat Loss Measurements

		Total heat loss Btu min	Heat loss per unit of bosh area Btu min per sq ft	Heat loss per ton of hot metal Btu
Carbon lined bosh No. 10 blast furnace	Test 1	47,843	57.13	
	Test 2	49,137	58.69	
	Test 3	45,771	54.66	
	Average	47,584	56.83	48,000
Conventional bosh No. 7 blast furnace	Test 1	71,705	71.04	
	Test 2	62,224	61.64	
	Test 3	58,176	57.63	
No. 4 blast furnace	Test 1	90,329	61.20	
	Average	70,609	62.88	63,000

BIBLIOGRAPHY

1. J. H. Chesters, G. D. Elliott and J. Mackenzie: Journal of Iron and Steel Institute 1951, Vol. 167, pp 273–282.
2. J. M. Stapleton and W. S. Debenham: Yearbook of the American Iron and Steel Institute 1953; pp 269–283.
3. J. M. Walsh, Jr.: Blast Furnace and Steel Plant 1953, Vol. 41, pp 1439–1550.
4. R. V. Flint: Proceedings, Blast Furnace, Coke Oven and Raw Materials Committee—AIME 1952, Vol. 11, pp 49–68.

DISCUSSION

PRESENTED BY

JAMES S. FRAZER, JR., General Supervisor—Power & Fuel, Engineering Dept., Duquesne Works, United States Steel Corp., Duquesne, Pa.

E. K. MILLER, JR., Assistant Division Superintendent, Blast Furnaces, Gary Steel Works, United States Steel Corp., Gary, Ind.

FRED R. FIELDING, Chief Engineer, Republic Steel Corp., Donner Plant, Buffalo, N. Y.

GEORGE FRENCH, Assistant to Superintendent, Blast Furnace Div., Bethlehem Steel Co., Bethlehem, Pa.

James S. Frazer, Jr.: I noticed on Table I that there was a difference in the heat transfer between the carbon and the ceramic bosh. Have you made a comparison of the water cooling flow rates between the carbon bosh and the original ceramic bosh? I might add that it will be interesting to see how bosh life on this furnace will compare with the original bosh using conventional construction and cooling methods.

E. K. Miller, Jr.: The water flow for the carbon bosh is approximately 60 per cent that of the conventional bosh.

Fred F. Fielding: I would like to know what percentage of the area of the bosh is covered by the channels?

E. K. Miller, Jr.: The total area covered by the cooling channels is approximately 56 per cent.

George French: How do you protect the bosh linging during blow-in? Do you cover it with a skin wall?

E. K. Miller, Jr.: That is correct. The skin wall is placed on the entire surface, clear up to the mantel.

. . . . . recovery of metallics in slag yard operation can pay profitable dividends . . . . in a typical plant with a production of 2,500,000 ingot tons, some 50,000 tons can be recovered . . . .

METHODS FOR RECLAIMING AND PROCESSING SCRAP from steel plant slags and refuse

By LAWRENCE J. FRITZ

Assistant to General Superintendent

Heckett Engineering, Inc., Butler, Pa.

▲ WITH the highest scrap prices in history prevailing and high grade native ores becoming more scarce, it has become necessary for steel companies, more than ever before, to utilize every available ton of metallics originating within their plants.

It is true that bloom ends, scrap sheet, rejected material, etc., are prepared and recharged into the furnaces. It is equally true that most mills do recover a certain amount of scrap from the slags and refuse material originating in the melting shops. It is, however, in this latter material that a sizable amount of scrap is lost by many steel plants, and it is with this material that this paper deals.

The following is a brief description of the various ways slag and refuse are processed and wasted:

1. Dumping slag pots and refuse material directly into a wasting area, with the idea in mind of eventually recovering the contained metallics by mining operations.

2. Dumping slags and refuse material in a slag yard, then sweeping this material with a magnet, thus recovering part of the contained metallics. The surplus slag and refuse then is reloaded into cars or trucks and transported to a wasting site.

3. Dumping the slag and refuse material into open pits, digging the material with mobile shovels or draglines, then sweeping the material with magnets before or while it is pushed over the wasting bank.

4. Dumping the slag and refuse into open pits, then processing all of the material through a magnetic separator which consists primarily of revolving magnetic drums.

The practice of dumping the unworked slag and refuse material directly into dumps has for the most part ceased in this country; however, the practice still continues in steel plants located in other parts of the world. Where this is done with the idea of eventually digging and processing the material for scrap recovery, three factors do in many cases affect this plan.

1. The land formed by this fill is eventually utilized by the ever expanding mill.

2. The dumps containing, in many cases, sizable amounts of cinders and other combustible materials burn out thus making rehandling for scrap recovery uneconomical.

3. The mixing of quantities of blast furnace slag with the open hearth slag and refuse solidifies the mass making it uneconomical to process.

The recovery of metallics within a slag yard is a method used by many steel plants. From a scrap recovery standpoint the efficiency of this method is proportionate to the following factors:

1. The size and use of the available operating space in the slag yard.

2. The number and condition of the overhead cranes engaged in breaking up and sweeping the slag and refuse.

3. The attitude and efficiency of the crane operators.

4. The proper transportation service furnished as scheduled.

For a particular plant there may be additional factors that will affect the amount of scrap recovered utilizing magnets in a slag yard, but regardless of the degree of efficiency when this method is used, free metallics are lost. The amount of the loss in metallics of course depends on the above factors.

As an illustration of the inefficiency of typical slag yard scrap recovery operations, the following will give a good example:

Formerly at a representative steel plant, all the slags and refuse materials were first dumped and processed in a slag yard. The swept material was then loaded into air-dump cars or trucks and dumped into open pits near the wasting bank for further processing. The metallics recovered were separated into two classes and the average recovery and analysis over a four-year period at this plant was as follows:

1. Blast furnace material between $+\frac{9}{16}$ in. and -3 in. containing 65 per cent Fe was 0.72 per cent of ingot production.

2. Open hearth material between $+3$ in. and charging box size containing, after cleaning, 85 per cent Fe was 1.67 per cent of ingot production.

Figure 1 — This magnetic separator handles 200 yards per hr.

Thus, it can be seen by projecting these actual production percentages to a steel plant having say an annual ingot capacity of 2,500,000 tons, and a recovery efficiency similar to the above, the following additional quantities of metallics could be recovered for blast furnace and open hearth use:

1. Blast furnace—18,000 tons annually—(1,500 tons monthly).
2. Open hearth—31,750 tons annually—(2,563 tons monthly).

We have found that in the handling and processing of slags and refuse materials that the most efficient method of recovering free metallics contained in these materials is to utilize the combination of a magnetic separator and heavy duty cleaning equipment.

We have found that the dumping of slags and refuse material into pits is a very efficient way of handling hot slag and refuse material. The pits into which the material is dumped should be approximately 50 ft wide and each pit should be between 200 and 300 ft long or sufficient to hold a 24-hour output of material. A total number of three pits should be available so as to allow adequate cooling time.

After a pit is filled, water is sprayed on the material and the slag is broken up by means of a 10 to 20-ton drop ball. At this point, large pieces of steel are removed from the pit by means of lifting magnets and hauled by truck to the cleaning facilities. The balance of the material is dug with a dragline and fed directly into a magnetic separator.

Two sizes of separators are in use at the present time, one having a capacity of between 150 and 200 yd per hr. A new larger capacity machine has recently been developed which will handle 400 to 450 yards of material per hour. Figures 1 and 2 show the respective machines in operation. The larger machine was designed primarily for volume operations and is currently being fed with a 6-cu yd bucket. These machines have undergone many evolutionary changes through the years, each change tending to prevent jams and improve production. Because of the very abrasive material, all wearing surfaces of the machines are manganese steel.

The standard machine normally delivers metallic materials in three classes, in addition to the over-sized material discharged from the grizzly:

1. Material for open hearth use consisting of 3 in. metallics to minus 14 in.
2. Material for blast furnace use sized from $+\frac{9}{16}$ in. to minus 3 in.
3. Material for blast furnace use sized from 0 to minus $\frac{9}{16}$ in.

Figure 2 — New separators handle up to 450 yards per hour.

Figure 3 — Cleaning barrel removes slag from metallics.

Figure 4 — Machine cleans by a combination of tumbling and abrasive action.

Figure 5 — Lifting magnets load scrap into hopper for cleaning barrel.

This latter 9/16-in. material is passed over a screen cloth and thence over a special type magnet. The final product contains an Fe content of 50 per cent or higher. At some operations, 1000 to 1500 tons of this material are recovered and charged into blast furnaces each month.

The second class of material is refined to 60 to 65 per cent Fe, but to arrive at this Fe content, this material may have to be refined by passing it back through the machine. To obtain a greater amount of blast furnace scrap, some mills prefer at the cost of paying a premium, to include all metallics up to 8 in. for blast furnace use. Where this is done the resulting metallics contain 70 per cent Fe or higher.

The open hearth metallics discharged from the separator contain approximately 75 per cent Fe. This material is transported to a patented continuous flow tumbler barrel for cleaning.

The cleaning barrel shown in Figures 3 and 4 is also a revolutionary development for scrap preparation use. The machine consists basically of five parts and its operation is as follows:

Scrap containing adhering slag from the separator is loaded into the hopper as shown in Figure 5 by use of lifting magnets. The inside dimensions of the barrel proper are 5 ft square. The material as it passes through the machine is cleaned by a combination of tumbling and abrasive action and the adhering slag which contains some small metallics is removed and falls through 3-in. openings to a conveyor located directly under the barrel. This material is conveyed to the end of the barrel, and empties into a second conveyor which carries the material to a storage bin. The clean open hearth scrap is discharged from the end of the barrel into a pit and is then loaded by lifting magnets into railroad cars, trucks or charging buggies. The Fe content of this material is 80 to 90 per cent. The material in the hopper, consisting of slag and small particles of steel, is removed periodically and passed again through the separator to reclaim additional blast furnace material.

Proper maintenance of equipment is an important factor in operation. Heavy loads, together with handling unusually abrasive material and working under dusty and dirty conditions, often cause unusual wear and tear on the machines. The large capital investment per unit makes it prohibitive in cost to maintain standby units, particularly with regard to special machines. The logical answer to this might seem to be to use more and smaller units of equipment; however, we have found that the most efficient operation results from using a relatively small number of well designed, large units, and let us emphasize the "well designed." The standard machines, such as cranes, bulldozers, etc., are satisfactorily maintained in a complete repair shop and with competent, well-trained mechanics at each job. As an example of the maintenance facilities required, each plant is capable of, and does when required, a major over-haul of any piece of equipment used on the job. In our preventive maintenance program, an attempt is made to spot potential troubles ahead of time, and the machines are brought in for partial over-haul and corrective maintenance before the trouble becomes of serious nature. In addition, machines are brought into the shop periodically for a complete over-haul.

DISCUSSION

PRESENTED BY

W. C. SCHULZ, Superintendent General Mechanical Dept., Bethlehem Steel Co., Steelton, Pa.

R. M. DENGLER, Assistant Superintendent Yard Dept., Bethlehem Steel Co., Bethlehem, Pa.

J. L. DAVIES, Heckett Engineering, Inc., Butler, Pa.

W. C. Schulz: I notice that you had some dump pans that were under the big separator. What is the capacity of those pans and what is the size of that tractor you have hauling them around?

R. M. Dengler: You mentioned having three pits for slag, and I believe you also said you dump your refuse in those pits, is that correct?

I also believe you mentioned that the pits should hold about 24 hours of production. Does that mean that you can cool that molten slag enough in the interim to process it?

J. L. Davies: First, the size of the box is eight cu yd. We took the body part off, a Euclid 80 FD and just mounted dump equipment on the back of it. We are thinking about using larger boxes. Every time we buy something we find out that it probably should have been two or three times larger than what we have, but you reach the point where people just do not build them any larger.

In answer to the question about the number and the size of the pits for handling the slag and the refuse, I stated that the pits should be fifty feet wide from center to center of the two tracks, the dumping track and the loading track, and approximately two hundred feet long. Normally for a steel plant having an ingot production of 4,500,000 tons, such as shops similar to Inland Steel Co. at East Chicago, or Youngstown Sheet and Tube at Indiana Harbor, three pits are enough to handle the slag and the refuse. We cool with water. We usually have two pits for slag and one for refuse. We do not have to cool the refuse; we handle the refuse in the pit, and it is dumped from hopper cars into the pits. The two pits for the slag normally are enough to take care of the slag resulting from the production of 4,500,000 ingot tons a year. So we could project and find out just how much pit space is needed to handle the volume of slag generated by your plant.

W. C. Schulz: You talked about some of these draglines in big sizes. What is the biggest piece of equipment you use?

J. L. Davies: The largest piece of equipment that we have, as far as dragline equipment is what may roughly be called a six-yard machine. It is a walking dragline. Normally for slag pot work and for dump digging, we use the equivalent of a Lima 2400 or a Manitowoc 4500.

We think that for the transportation equipment that we have, the recovery equipment, the separator and cleaning equipment that we work in conjunction with it, that a four and a half to five-yard machine, dragline, is big enough for the work.

By J. E. HOVIS, Manager
Industrial Furnace Division, The Gas Machinery Co., Cleveland, Ohio

Mill Requirements Point to Five-Zone Furnace

▲ THE purpose of this paper is to review heating requirements as dictated by present mill practice, view their effect on furnace operation, and finally to consider possible improvements in continuous reheat furnace design which direct toward better fulfillment of mill demands.

The need for review of furnace design stems primarily from the high production demand confronting the mill operator today as compared to years past, and to some extent from more critical quality and operating cost situations. It is by no means the intention of the writer to infer that past furnace designs were inadequate—for the designer was certainly guided then by a situation far different from the present.

Prime phases of the heating operation which must be carefully scrutinized by the designer include:

Tonnage requirement.

Variable steel thickness—as evident in heating operations for plate and structural mills.

Extreme temperature difference—surface to center—encountered when heating thick steel.

Skid marks.

Space limitations.

Hearth length limitations—set forth by pile-up problems on thin steel or in certain cases "stickers" on relatively thick steel.

Fuel economy.

The foregoing points up pertinent aspects of operation toward which furnace design must be directed if mill requirements are to be properly met.

The following discussion, limited in scope to specific operations on several types of mills, serves to demonstrate the nature of the problems confronting the furnace operator under conditions of high production demand and suggests an improvement in furnace design which substantially overcomes these problems.

STRUCTURAL MILL FURNACES

For the case to be considered, stock size may vary from 6-in. squares to 14-in. thick blooms with 9-in. blooms as a common intermediate charge. Scheduling avoids the necessity of heating extreme mixtures of these blooms, but changeover from one size to another may necessitate charging 9-in. against 14-in. thick blooms. Frequency of changeover varies but could occur two to three times per turn.

Figure 1 indicates a conventional three-zone reheat furnace operation for 14-in. and 9-in. thick blooms under condition of mixed loading. Temperature is plotted on the ordinate and time in minutes on the abscissa.

The method used in calculating the heating curves is similar to that suggested by Fred S. Bloom in a paper titled "Rate of Heat Absorption of Steel," 1955 Proceedings AISE. The method in essence consists of establishing the furnace temperature curve from experience on similar heating operations, estimating the surface temperature curve, and then for short-time intervals calculating the center temperature.

The accuracy of the surface temperature selection is readily checked since "time lag" between center and surface is essentially constant for a given size and type of material except in the critical and soaking stages. Surface emissivity of 70 per cent was used on all curves considered herein.

The furnace temperature curve for this type of furnace does vary with type of fuel used, flame characteristic which depends on burner design, and knuckle height among other factors; however, when considering that bottom zone temperatures usually run colder than top zones—in some cases by as much as 200 F, the 2375 F average temperature shown here is believed to be indicative of practice.

The heating operation indicated by the curves is a good one in that no serious overheating can occur either in the case of a 14-in. thick steel where time lag between center and surface is 44 minutes; or under condition of charging 9 in. against 14 in., in which case the 9-in. hits furnace temperature about halfway through the hot zone.

The advantage evident in operation at limited furnace temperature is gained at the price of a similar limitation of heating rate. The indicated heating rate of 95 lb per sq ft per hr viewed in the light of high production demand is not a favorable one.

For example, if required production rate be 150 tons per hr based on 14-in. thick blooms totaling 30 ft long, then furnace length must be 105 ft. This length of furnace weighed against thick steel as treated here is well beyond the extreme of good practice from the standpoint of "stickers," for on thick steel it seems desirable to limit furnace length to about 70 to 80 ft.

. . . . the five-zone furnace is suggested as a nonconventional design which can meet high mill demands within the minimum furnace length and yet achieve product flexibility . . . . unit is composed of proven components . . . .

Further, space limitations in certain cases dictate minimum furnace length.

Now, considering means of increasing heating rate substantially above that indicated by Figure 1, in order to cut furnace length with conventional furnace design, the only approach is increased furnace temperature.

Figure 2 plots heating curves for 14-in. and 9-in. blooms resulting from operation of a three-zone furnace at high hot zone temperature.

The operation pictured does show a relatively high heating rate—120 lb per hr per sq ft on 14-in. as compared to 95 lb per hr per sq ft with limited hot zone temperature—but it also indicates a condition with which the operator cannot live.

Even without mixed loading on the 14-in. steel, surface overheating is evident. Again realizing that the bottom zone temperature normally runs colder than the top, it is understandable that the top surface would overheat even more severely than shown. When mixed loading is encountered, the 9-in. steel will again hit furnace temperature in the hot zone causing extremely severe overheating. Therefore operation of the conventional furnace in this manner on the stock considered is ruled out.

Thus the furnace designer, faced on the one hand with high production requirement and on the other with a hearth length and hot zone temperature limitation, must either look toward a nonconventional design directed toward high heating rate, or consider using additional furnaces of conventional design and of reasonable hearth length. Considering for the moment nonconventional design, he must direct his attention to the cold end of the furnace for it is there that furnace temperature can be increased substantially without overheating the steel.

Figure 3 shows a five-zone furnace arrangement which, through the addition of two firing zones at the charge end of the furnace, operates at a considerably higher temperature in the back end; and therefore offers a very favorable heating rate, namely 125 lb per sq ft per hr. Hot zone temperature is held to 2375 F thereby avoiding overheating. Using the same example as before—150 tons per hr on 14-in. thick, 30-ft long steel—the furnace length would be 80 ft, which is within the hearth length limit.

It is noted that although the 9-in. bloom would hit

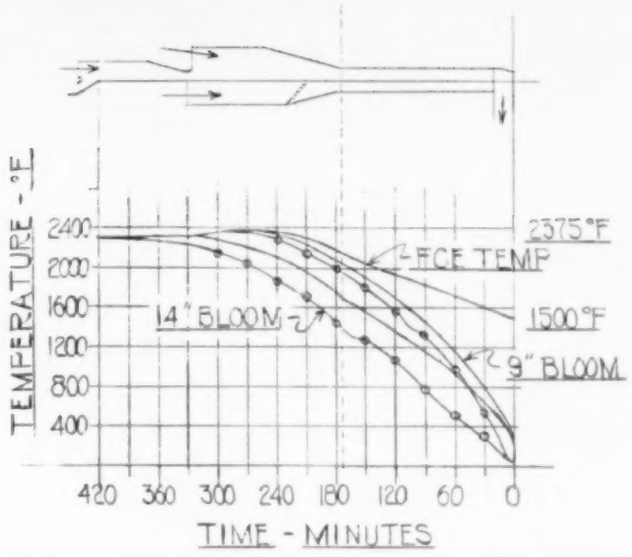


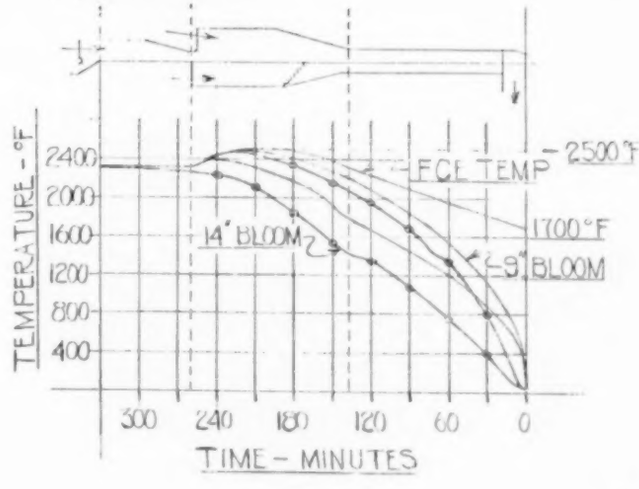
Figure 1 — Chart gives data for structural mill furnace with heating rate of 95 lb per sq ft per hr while heating 14-in. bloom.

furnace temperature well back in the furnace, it would enter the soak zone after 250 minutes as compared to 330 minutes under the conditions of Figure 1.

Thus the five-zone furnace presented here would meet a high tonnage requirement, properly accommodate mixtures of steel and thick steel, and be favorable with respect to hearth length. Recent advancements in burner design make injection of substantial amounts of fuel that close to the charge end quite practical; however, waste gas temperature out of the furnace will be appreciably higher. Fuel economy will be discussed later in the paper.

An alternate approach to satisfying high demand could be the use of conventional furnaces, but with length held to a desirable limit. The total tonnage on the mill may be 300 tons per hr and at a heating rate of 95 lb per hr per sq ft for 14-in. thick blooms totaling 30 ft, three furnaces, 70 ft long, would be required as compared to two 80-ft 5-zone furnaces. When considering such factors as first cost and space limitation, it is doubtful that such an alternate could be feasible.

Figure 2 — Chart gives data for structural mill furnace with heating rate of 120 lb per sq ft per hr while heating 14-in. bloom.



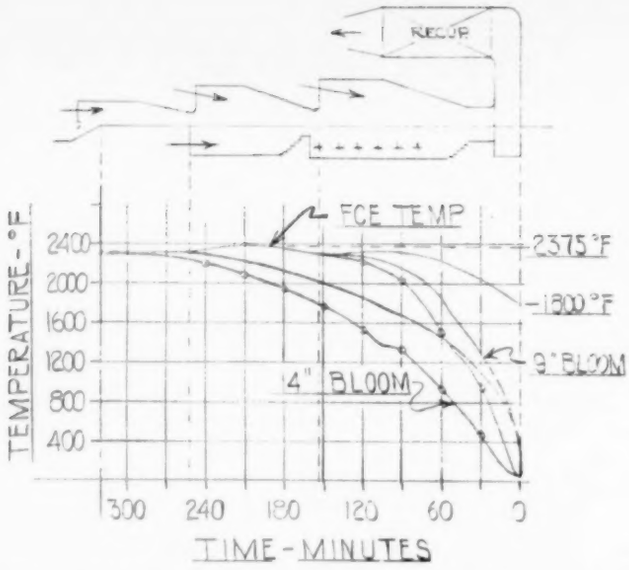


Figure 3 — Chart gives data for five-zone structural mill furnace with heating rate of 125 lb per sq ft per hr while heating 14-in. bloom.

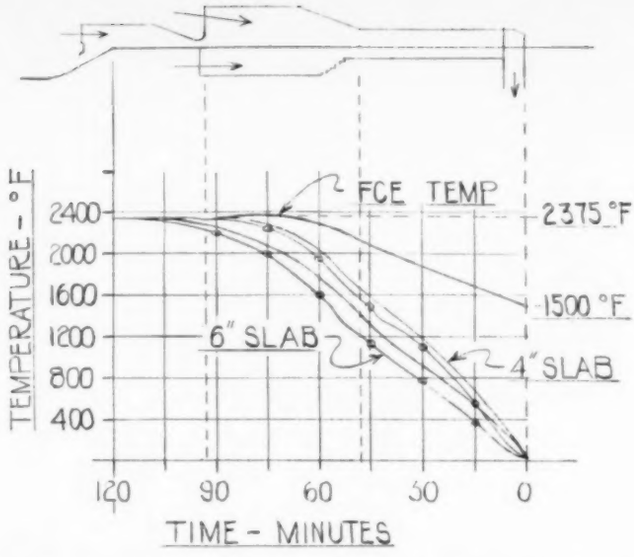


Figure 4 — Chart gives data for plate mill furnace with heating rate of 120 lb per sq ft per hr while heating 6-in. slabs.

PLATE MILL FURNACES

Considering a specific operation, slabs may vary from 4 to 12 in. thick with a large part of production falling in the 4 to 6 in. range. Scheduling avoids severe mixtures of slab thicknesses, but changeover from one size to another may necessitate charging 4 in. against 6-in. slabs. Pile-up problems on 4-in. slabs set a hearth length limitation of approximately 80 ft.

Figure 4 shows the heating operation on 4 and 6-in. slabs under condition of mixed loading for a three-zone furnace. In this case, surface overheating is not a factor since time lag on the 6-in. slab is only approximately seven minutes; however, when heating 4 in. against 6 in., average furnace temperature is again limited to 2375 F in order to avoid overheating the 4-in. slab. Under these conditions, a heating rate of 120 lb per hr per sq ft is realized.

A reasonable maximum tonnage requirement may be taken as equivalent to 100 tons per hr based on 6-in. slabs heated under conditions of mixed loading—that is, with limited hot zone temperature. Actual tonnage would be reduced by the ratio of 4-in. slabs in the furnace. With a heating rate of 120 lb per sq ft per hr, the required furnace length would then be 110 ft for 15 ft total steel length. This is far in excess of the 80 ft limit.

Figure 5 plots the heating curves for 4 and 6-in. slabs heated in a three-zone furnace, but with high hot zone temperature. The indicated heating rate of 160 lb per sq ft per hr satisfies the tonnage requirement with an acceptable furnace length of 83 ft; however, severe overheating of the 4-in. slabs is encountered. Thus similar to the case of the structural mill furnace, attention must be given to the cold end of the furnace if production demand is to be met by increasing heating rate.

Figure 6 plots the heating curves for the five-zone furnace operation with hot zone temperature limited to 2375 F. Here again the high production requirement is fully met, yet overheating avoided.

Again considering a tonnage rate of 100 tons per hour, equivalent on 6-in. slabs with 15 ft total slab length, the furnace length would be 83 ft, which also falls in line with the hearth length limitation.

Considering a 200-ton per hour mill demand and conventional furnaces, three 75-ft long furnaces would be required as compared to two 83-ft, 5-zone furnaces. This comparison again points in favor of the 5-zone furnaces.

STRIP MILL FURNACES

The heating operation for the strip mills differs sharply from that of the structural and plate mills. Slab thickness as charged is substantially uniform and in the range of 4 to 9 in. thick, such that surface overheating is not a serious factor. Thus, average furnace temperatures of 2500 F are evident in practice with heating rates of 160 lb per sq ft per hr readily realized. Nevertheless, with increasing demand, improvements in mill equipment and practice often place an even greater load on the furnace equipment. In such a situation where mill capacity can be stepped up appreciably beyond furnace capacity, one way out is to add another furnace which may well be the correct solution. However, as is possible in existing mills, it could be that there is no room. Under such circumstances, attention is immediately focused on increasing capacity of existing equipment. This situation points to nonconventional furnaces accomplished through rebuild.

Figure 7 plots the heating curve for a 6-in. slab based on a five-zone furnace operated at high hot zone temperature. The heating rate indicated is 195 lb per sq ft per hr as compared to 160 lb per sq ft per hr shown by Figure 5 for a three-zone furnace. Thus the five-zone furnace could well serve such a situation. The five-zone design is also felt to be worthy of consideration on new strip mills.

Speaking generally of the five-zone furnace, the addition of the two firing zones in the cold end of the furnace places fuel much closer to the charge end than with the three-zone furnace. The amount of fuel is

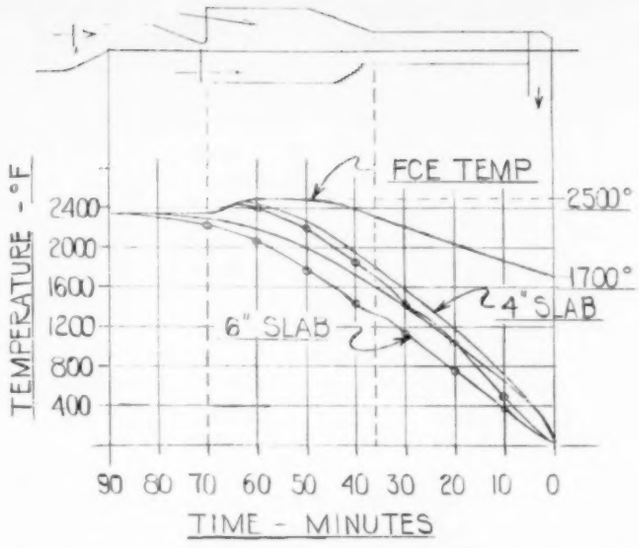


Figure 5 — Chart gives data for plate mill furnace with heating rate of 160 lb per sq ft per hr while heating 6-in. slabs.

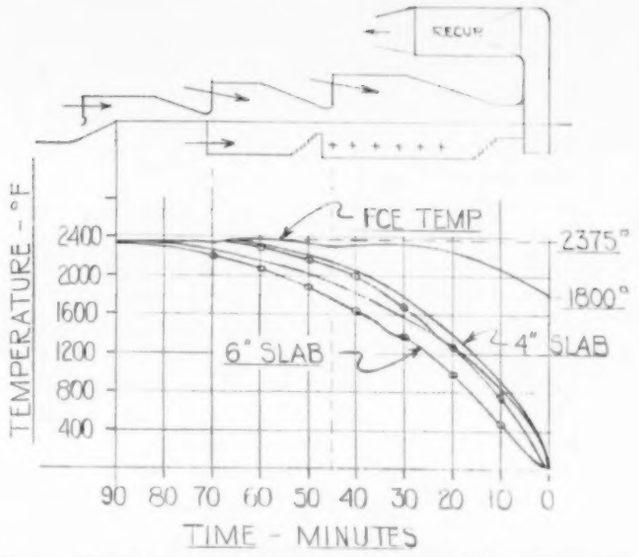


Figure 6 — Chart gives data for five-zone plate mill furnace with heating rate of 160 lb per sq ft per hr while heating 6-in. slabs.

considerable. It is, therefore, imperative that combustion be completed rapidly in firing zones of sufficient volume properly utilized.

In the last few years, burner improvements in the form of fast burning semi-luminous flames have been made and successfully applied to a number of furnaces of the type considered here. With this type of burner, combustion can be completed within the confines of the charge end zone such that only spent products pass under the knuckle.

On the three-zone furnace with a charge end temperature of 1500 F, waste gas temperature would run approximately 1600 F. On the five-zone furnace with an 1800 F charge end temperature, waste gas temperature is expected to be approximately 2100 F.

Now considering equivalent recuperators—namely, with transfer surface held in constant proportion to design tonnage—preheated air temperature for the five-zone would be approximately 840 F as compared to 640 F for the three-zone furnace. Charging the higher waste gas temperature against the five-zone furnace, but crediting it with the higher air preheat, the loss of efficiency amounts to approximately 7.0 per cent.

One compensating factor is evident. Using the plate mill considered previously as an example, three three-zone furnaces, 75 ft long, are required to meet the production of two 83-ft, five-zone furnaces. Thus furnace losses, such as skid loss, wall loss, door losses, etc., on a per-ton basis are lower for the five-zone furnaces. A fair estimate is approximately 50,000 Btu per ton.

Therefore if credit is also given for this factor and the straight-run figure for three-zone furnaces be taken at 1,600,000 Btu per ton, the comparable figure on the five-zone furnaces would be approximately 1,660,000 Btu per ton.

Larger recuperators giving air preheat of approximately 985 F would bring the fuel rate of 1,660,000 Btu per ton down to that of the three-zone furnace. Admittedly, price of recuperation in this range comes high; but with the maintenance picture established by practice and yearly savings a known figure, the economics of added recuperation can be evaluated.

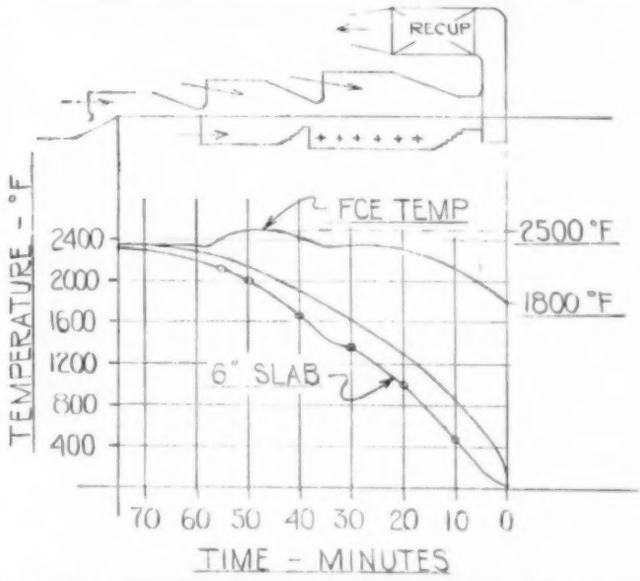


Figure 7 — Chart gives data for five-zone strip mill furnace with heating rate of 195 lb per sq ft per hr while heating 6-in. slabs.

Thus the five-zone furnaces, in spite of high waste gas temperature, are not too unfavorable from the standpoint of fuel economy.

Skid marks were mentioned in the introduction as an important consideration of the furnace designer and this refers particularly to slab heaters. To some operators they are not a problem; to others they are quite serious in that production is limited. If such be the case, the operator may well be cautious of increased heating rates, for time on the soak hearth is reduced.

In some cases, even after the soak, skid marks are quite pronounced, extending to the top surface of the slab. In such cases, it is doubted that increasing soak hearth length within reasonable limits will even touch the problem. Insulating longitudinal skids undoubtedly helps; but beyond that, the best corrective step possible is believed to be materially improving heating conditions on the bottom of the slab.

In other words, build into the furnace means for

doing the required heating job on the bottom of the slab prior to the time it hits the solid hearth. The five-zone furnace with two underfired zones is doubtlessly a step in the right direction. Whether heating rates in the range of 200 lb per sq ft per hr can be accomplished without serious skid marks is not known, but adequate underfiring should certainly come close.

The foregoing discussion has suggested a nonconventional five-zone furnace as one means of meeting high mill demand. It has further demonstrated how various aspects of heating operations point toward such a furnace under condition of high demand. The suggested design does constitute a departure from present practice; on the other hand, it is comprised of proven components.

Selection of proper heating equipment for a given mill operation carries a serious responsibility both to the user and to the furnace supplier. However, deviation from convention is desirable and necessary, provided adoption of new designs leads to better fulfillment of mill demand.

DISCUSSION

PRESENTED BY

RICHARD EWALT, Manager of Sales, Rust Furnace Co., Pittsburgh, Pa.

ROBERT QUINLAN, Fuel Engineer, United States Steel Corp., Fairless Works, Fairless Hills, Pa.

HERMAN HENSCHEN, Combustion Engineer, Fuel Dept., Bethlehem Steel Co., Sparrows Point, Md.

FRED S. BLOOM, President, Bloom Engineering Co., Pittsburgh, Pa.

GEORGE H. KRAPF, Division Superintendent Power Production, United States Steel Corp., South Works, Chicago, Ill.

EDWARD T. W. BAILEY, Chief Engineer, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

J. E. HOVIS, Manager, Industrial Furnace Div., Gas Machinery Co., Cleveland, Ohio

Richard Ewalt: This paper is a little bit hard to discuss because at this time we have no five-zone furnaces in operation, and I feel the best thing I can do is to give you a few facts that we have on existing three-zone furnaces and then to present a few points for thought on five zone furnaces.

At the present time, we are having sustained runs of heating rates with a maximum of 170 lb per sq ft per hr, and this has been taken over several 8-hour shift runs. In realizing this maximum heating rate, we find that a waste gas temperature at the charging end of the furnace has to run somewhere between 1850 and 1875 F, that is at the downtakes.

In operating in this manner, the author mentioned the combustion air temperature of about 985 F, I believe. We have found that operating at maximum rates on conventional three-zone continuous furnaces we need a flame inside the furnace of a very luminous character traveling the entire length of the heating zone of the furnace, and have found that if we get preheated air temperatures of over 800 F we do not get this desirable luminosity in the flame. At the present time, we do not know of any burner design that will give us this luminosity with a high preheated air temperature.

The author mentioned length of push in these furnaces. Present practice in mills is to go to a longer and heavier slab which minimizes the length of push. Of course, that results in heavier coils.

Some of the points that we might consider about five-zone furnaces are initial cost of the two extra zones, and the maintenance of these two extra zones and an additional water cooled knuckle.

The author also mentioned the fact that two furnaces could replace three or more. We have to consider under that flexibility as to production realized. If one of the two furnaces was down for maintenance purposes, then all of our eggs would be, so to speak, in one basket, and if something happened to the remaining furnace, we would miss all of our production on the mill.

We have realized the need for higher heating rates and more production and capacity in continuous furnaces for some time. I can tell you now that within the next 10 to 12 months we will have several of these five-zone furnaces in operation and after that time I think we will be able to give you better facts and figures on what they will do.

Robert Quinlan: I agree that the present day demands on re-heating furnaces require more flexible operation than that of a few years ago. The operators today are faced with various orders requiring charges in many grades and thicknesses. I want to point out, that this is not limited to structural mill furnaces. It is also serious in the strip mills.

The five-zone furnace would give the flexibility needed for a good furnace operation and, I believe, with proper control over each zone, the problems caused by mill delays, hot and cold charges, and various charge thicknesses, can be reduced.

Herman Henschen: The subject of skid marks, is very controversial, and one which may promote some arguments. The skid marks which were mentioned in the paper are sometimes a serious problem. We have made several observations of their character in hopes of finding ways to minimize their effect. In one case, the soak zone of one of four furnaces was increased from 17 ft-4-in. long to 21 ft-7 in. long. This 25 per cent increase in soak zone did not produce any measurable skid mark improvement.

Similarly, we found that careful observation of the edge of a slab as it is first uncovered by the departure of its neighbor out the drop-out, shows how little the soak zone has reduced the skid marks on the slab. To our surprise, we found that even with adequate heat soaking had penetrated the skid mark only about 1 or $1^1/_2$ in. of the total slab thickness of about 6 in. It is little wonder, then, that a mere 25 per cent increase in soak time produced such a meager result.

It is also interesting to note the development of skid marks after a sustained mill shutdown. Even though the mill might be rolling at a fast rate and time in the soak zone is short, skid marks do not become objectionable until the supply of well soaked steel from the hot portion of the main heating zone—and I am not considering just the soak zone itself—has been exhausted. This seems to be further proof that when heating in the main

heating zone is adequate, skid marks are quite tolerable.

We believe that either insufficient heating of the slab bottom or heating too quickly within a limited space of the furnace length makes soaking out of the whole slab almost impossible, and that this condition manifests itself in obvious skid marks. We believe that any system which will start heating the slabs sooner and heat them equally from both sides will go a long way in the reduction of skid marks. The five-zone furnace is certainly a logical approach to this problem.

Fred S. Bloom: The author failed to mention one point which I think should not be overlooked in any discussion of a five-zone continuous pusher type heating furnace. The addition of one or two firing zones near the charging end of the furnace adds flexibility. A single-zone continuous billet heating furnace and the triple-fired billet heating furnace are quite inflexible in the heating pattern. What I am trying to say is that with a given furnace roof design and burner application, we get a fixed temperature distribution pattern throughout the furnace which cannot be changed. We get what the furnace designer builds into the furnace. Sometimes this suits the material being heated and sometimes it does not.

In the operation of our present pusher type furnaces, the steel is allowed to be super-heated in the charging end of the furnace during the delay period. This means that the steel inside the charging door of the furnace will increase in temperature as much as 700 F, and in some cases under poor operation, the steel inside the charging door may become red hot during this delay period.

We have tried to emphasize this condition many times because it is the start of all the trouble that is experienced with the triple-fired furnace. It causes a slag condition in the bottom zone and creates a high furnace maintenance problem, because when the mill delay is over and steel is discharged from the furnace, cold steel must necessarily be pushed into the furnace. There is no possible way for the triple-fired furnace to heat the cold steel without overheating the super-heated steel directly ahead of it. All the heater can do with this situation is to wash the super-heated steel in attempting to properly heat the entering cold steel, and that is what the average heater does. That is why we get slag and high furnace maintenance.

Now, let us take a look at a furnace proposed by Mr. Hovis where we have two additional firing zones, one above and one below the steel near the charging end of the furnace. Regardless of the skill of the heater, we have provided a means of applying heat to the cold steel directly entering the furnace without affecting the hot steel which is pushed ahead of the cold steel. We no longer have to depend on using the main heating zone burners to heat the steel in this period of operation. Thus, if the five-zone furnace gave us no ability to heat more steel, we would still have a greatly improved furnace operation, because of the flexibility in properly applying heat to the spot where it is needed, and we will eliminate the washing of the steel and improve our furnace maintenance. The flexibility of this furnace design should warrant its consideration, even though we may not wish to sacrifice fuel economy for improved tonnage.

As Mr. Hovis has brought out, the temperature pattern with a multiple-zone slab heating furnace is not the same for thin steel and thick steel. This is one of the reasons why, with a conventional three-zone slab heating furnace, we get less tonnage with thick steel than with thin steel. If we have additional firing zones, we can change the temperature pattern with the furnace so that the same tonnage can be heated with thick steel as with thin steel.

As a word of caution, in the design of the multiple-zone furnace, we must realize that the total burner capacity on the furnace will probably never be used at one time. For instance, if No. 4 and No. 5 zones are working hard, then No. 2 and No. 3 zones will not be working at maximum capacity. We have built into the furnace a flexible means of furnace operation, but the furnace engineer must realize that the total burner capacity cannot be added together in calculating the fuel input to the furnace. We must necessarily have more total burner capacity than ever will be demanded to be used on the furnace at a single instant.

George H. Krapf: The problem being discussed here, of course, brings up many thoughts, comments and discussions in regard to application, type of burners, type of flame, recuperation, and all the problems associated with a new idea of this nature. I personally feel that maybe we are indicating changes in our thinking in regard to the type of flame that we need and desire in high capacity furnaces. I feel that we have some experience behind us that indicates that we can use high preheat in our continuous furnaces. I know of one installation of high capacity continuous furnaces that are running with air preheat temperatures above 1000 F and that if this preheat temperature is lowered, that the furnaces slow down in production.

So that indicates that maybe we have other considerations in regard to luminosity that we have not looked at too carefully, or, if we have, we have not recognized them. That is that all luminosity in the furnace is not visible luminosity. The gases moving through the furnace have their own radiant characteristics, especially the carbon dioxide and water vapor, so that we get radiant heating from the gases themselves, even though visibly, with your eye, you do not see it.

In addition, we have to consider radiation from the brickwork, not only on the roof of the furnace but the sidewall of the furnace, the end walls of the furnaces, the hot burner face, all of which have a bearing on this problem.

I believe that in high capacity furnaces that anything we do to create uniform furnace temperature so that at any one spot we do not exceed the allowable temperature which will permit our furnaces to run dry is desirable. We must avoid melting the scale on the slab or billet that results in slag deposits and undesirable quality of the product. We must do this while making furnaces produce at high rates with good quality heating, and still avoid these non-uniformities that give so much trouble, especially in our shape mills.

So, it may be that the solution to the problem—and I am fairly well convinced that it is—is going toward some luminosity in our burners, very fast burning of the fuels, a high burner momentum so that we create uniformity in the furnace by the horsepower that is in the stream of burning gases leaving the burner. This idea might have a lot of application and help us solve

these problems that we face. In other words, if we can get all the brickwork in a particular zone of a furnace up to a given temperature, and we have no hot spots, we know that we are radiating uniformly to our slab or billet surfaces in that zone, and we have a real chance with our controls of keeping overheating down in any one spot.

I also feel that Mr. Henschen and the author, especially, put their finger on a most important problem and that is to heat the bottom of the slabs or blooms so that we do not push steel that is cold on the bottom.

Now, you have to remember that continuous skids run through these furnaces, and that skid marks, the cold streaks in the product, prints itself on the soaking hearth. In other words, you have a cold spot moving through on the soaking hearth and you keep pushing the steel through, so I am certain that the soaking hearth will bear that streak of low temperature, because there is no reason for it to be otherwise.

So, anything that we do to get more heat into the bottom certainly will help that particular problem.

Also, as has not been mentioned here, the five-zone furnace does lend itself to maybe placing the skids so that we do not have one continuous skid through the length of the furnace, where we can stagger the skids between the zones in order to attempt to even out this cold spot. That is another thing that it seems to me that we can gain with this extra zone in the furnace and certainly we should think about that.

We know from experience that a burner which develops almost complete combustion in a port operating with very high momentum—in other words, with above 10 in. of pressure at the burner—does give uniformity in a furnace chamber. We have such furnaces operating as soaking pits and we certainly welcome people to take a look at the results of that type of thinking.

Edward T. W. Bailey: What is the matter with 7 or 9 zones; and from where do you get information that you cannot push 4-in. slabs say 90 feet?

J. E. Hovis: With respect to the 7 or 9 zones, if the type of stock heated can be pushed the distance required, namely, through a quite long furnace, 125, 130 feet there is certainly nothing wrong with the 9 zones. Zone lengths are critical. They tie in very closely with the type of fuel used. We have experienced oil-fired furnaces with extremely sharp, fast burning flames and in those cases the furnace temperature curve throughout the furnace is far different from any of the gas-fired furnaces. There is a tendency to reach a sharp peak and drop off rapidly. In such cases, zone length cannot be extended too far, because we would end up with a number of dips in our furnace temperature curve.

On gaseous fuels, again, depending upon the type of burner used, longer zone lengths could be utilized and we can very reasonably picture, say, a 7-zone furnace.

As far as the limit on pushing a 4-in. slab, Mr. Bailey gave us a 10-ft credit, I think we mentioned 80 ft. The best answer I can give is that this limitation is based on practice. In other words, the jobs with which the writer has been associated or is familiar indicate on a 4-in. slab the push limit due to pile-ups is approximately 80 ft., I have heard of one furnace being considered, where it was specified 90 ft. Possibly you are not experiencing the pile-up problems that some people are, but the 80-ft limitation is more or less a statement of practice.

One thing that has cropped up here that Mr. Ewalt and Mr. Krapf touched on is the effect of the burner flame characteristic—what the chamber atmosphere is like—what it looks like. We look into a furnace and we say it is too clear, it will not heat right. On the other hand, under those very circumstances, we have experienced heating rates equivalent to those of a furnace with a heavy luminous flame.

There is, I think, a definite trend away from the heavy luminous flames. We have experienced it in other types of furnaces. One good example is the rotary furnace, originally all fired with long luminous flames, and as a result of that type of flame, we have run into much non-uniformity of temperature on the rotary hearth furnace.

The next step was to put on a sharper luminous flame, and it was felt that hearth uniformity was improved. The company with which I am associated is presently building a large seamless mill rotary furnace and we have gone completely away from luminous flames; we are using a very fast, clear flame burner, and the purpose of doing it is to get temperature uniformity in the chamber. Everything that we have checked, every change that we know of made in that direction has improved temperature uniformity, and we feel it will offer a marked improvement in the operation of that rotary furnace.

Getting back to the type of furnace considered here, we have checked to the best of our ability the affect of flame and in no case have seen an indication where heating rate suffers from a change from luminous to either semi-luminous or clear flames.

I think Mr. Krapf went into a very good discussion of other factors which provide the required heat transfer.

One other item I might mention relates again to the burners. Actually, contrary to what the sketches showed, longitudinal firing is preferable from the standpoint of being able to control temperature across the steel or along the length of the steel. The side firing shows up on the slides mainly because the furnaces shown were proportioned from a drawing of a relatively short furnace, in which case we have experienced difficulty in working in the required firing aisle for the longitudinal bottom burners, and have switched to the side firing.

Side firing on the surface may look bad in that you may feel that the ends would overheat. We are not too much worried about the burner walls since flame development takes time. We end up some 10 ft out away from the burner wall with our hot spot.

In the 2-row operation we can get into trouble with side firing, namely, on the inside ends. However, if we are operating under a condition of mixed loading with a limitation of hot zone temperature, no damage is done. If we hit the case where we are operating that type of furnace at high furnace temperature with a 2-row operation and side firing, we can get into trouble. Some correction, of course, is possible in the intermediate heating zone by adjustment of burners, but it is not the ideal condition.

Again, we prefer the longitudinal firing on furnaces roughly 75 ft and over.

By MICHAEL A. MATZ, Special Technical Assistant,
Continuous Sheet & Strip Dept., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

Reducing Smudge on Cold Rolled Sheet

. . . . control of smudge on cold rolled sheet is not dependent on any one condition . . . . variations in hot rolling, pickling and annealing practices may all affect appearance of smudge . . . . temperature should be such as to produce a scale high in FeO . . . .

▲THE problem of reducing the quantity of smudge on cold rolled sheets is of prime concern to the producers of cold rolled sheets. This smudge is of varied colors, is generally carbonaceous in nature, and is accompanied by the presence of one or more compounds of iron.

Messrs. Lillie and Levinson of the Armour Research Foundation presented a paper at the September 1956 Convention of the AISE relative to decomposition of DX gas during the annealing process and the subsequent deposition of carbon and various ferrous and ferric compounds on the surface of the sheets being annealed. It is the writer's contention that there are many other factors, that enter into this long chain of chemical reactions and which must be considered as having an important role in the all-over phenomenon.

The first of these is the mechanism of phase transformation of iron during all hot forming operations. This phase transformation, which occurs at approximately 1600 F as the metal cools, is the point where the face-centered cube of the austenite transforms to the body-centered cube of the alpha iron and is referred to as the A_3 point.

The mechanism of phase transformation of iron-carbon at this A_3 point appears simple enough when considered by itself. It would be, if we were concerned with only iron and carbon. However, we must bear in mind that today's low carbon commercial and drawing quality steels carry varying residual amounts of copper, nickel, chromium, molybdenum, tin and dissolved gases such as nitrogen, oxygen and hydrogen. Each of these by itself and in conjunction with the others, plays an important part in the phase transformation of iron and their presence retards or inhibits the formation of true body centered cubic ferrite. They may be responsible for the hardening of certain phases of the microstructure as well as the weakening of grain boundaries.

Automatically the high temperature form of steel follows that of iron. The atoms in a unit cell, which is the smallest unit of arrangement, are at each corner of the cubic lattice plus one on each face of the cube. This is the face centered cubic arrangement of the austenitic form of steel existing at temperatures above 1600 F. In this state Fe is capable of dissolving large quantities of other elements having similar atomic weights and of the same general size. These elements include copper, nickel, chromium, molybdenum and tin. This solution occurs by replacing or substituting for the iron atoms in the lattice. Relatively large differences in atomic sizes increase the distortion of the lattice with subsequent hardening and strengthening, since there is an interference with a slippage in the atomic alinement when stress is applied. In addition, the gases, hydrogen, oxygen and nitrogen, upon becoming dissolved in the metal, become located between the iron atoms on the lattice with a subsequent weakening and distortion of the lattice pattern; such is the austenitic structure of steel at above 1600 F.

As the metal cools below this point, the atoms must shift so as to produce a bodyfaced cube. The dissolved residual elements, metals, and gases, have an inhibiting effect on this transformation, and hinder the formation of the cube with the creation of faults or fractures within the grain boundaries. These faults represent a weakened microstructure that, later on during the pickling process, is more susceptible to the attack of sulphuric acid resulting in deeper pickling etches, more hydrogen embrittlement, and the carrying-over of pickle line contaminants on this over-pickled surface, which materially affect the amount of smudge that is found on cold rolled sheets.

This chemical reaction, has in many instances, been referred to as a unilateral action, extending over the surface of the steel being pickled. We have every reason to believe that it is a two-dimensional reaction, extending deeply into the surface of the metal as well as across its face. The presence of weakened grain boundaries at or very close to the surface of the metal offers very little or no resistance to the acid attack. This attack continues along these lines of weakened resistance resulting in wholesale dislodging of grains either by themselves or in groups. This reaction proceeds at different speeds and depths along the two-dimensional face. This roughened surface as it moves from one pickling tank to another in our lines carries on its surface large quantities of pickel liquor, iron salts and other products of the process. Due to the construction of our pickle line and methods of rinsing, these compounds are never washed off in their entirety, but due to subsequent interaction of cold and hot water are left on the surface of the coil as chemically active ferrous and ferric compounds. Upon coming in contact with the long chain molecular formula of rolling and precoating oil, many complex compounds are formed, principally carboxylates. The deeply imbedded pickle line residues are later forced to the surface during tandem reduction and the complex mass under the influence of friction, heat and pressure tend to partially decompose this oil resulting in the deposition of amorphous carbon on the surface of the steel being cold reduced. The rolling oil is never totally emulsified and the final analysis of wipe tests at the

tandem mills reveal many iron salts as well as some free iron. This can never be totally evaporated during the anneal since this sluggish mass with the suspended carbon is slow in vaporizing during the temperature spread of 750 to 900 F which does not extend for any considerable length of time. The final end result is the appearance of this black carbonaceous, iron-bearing smudge on the surface of the sheet in one of many patterns, namely; along the edges, or all over the sheet. Those deposits along the edges are generally more severe since the oil during the heating process failed to evaporate and collected mostly at the point of least resistance, to finally appear in one of many patterns, any one of which is objectionable.

We cannot afford to overlook the conditions that must be considered when the final oxide film is formed on the coils as they leave the finishing stands of the hot mill. It is generally agreed that a rapid cool from the finishing temperature to about 1200 F is believed to be an ideal coiling temperature. Let us examine the facts. As the coil leaves the hot mill, the iron at the elevated temperature reacts with oxygen to form the ferrous oxide, FeO. This compound is stable at temperatures of about 1065 F, at temperatures below this point this oxide decomposes and in the presence of oxygen forms, magnetic oxide, Fe_3O_4. This in turn further oxidizes to form Fe_2O_3. This oxidation reaction does not proceed at any predetermined rate, but varies with the presence of oxygen and decline of temperature. The amounts of Fe_3O_4 and Fe_2O_3 can never be of excessive quantities if we have coiled the steel above 1065 F and have produced a tightly evenly wound coil. The oxide film which is then formed is of the admixture type, varying in thickness and percentages from the highly oxidized edges to nearly no oxide on the main body of the coil. Such an oxide film, rich in FeO can be easily removed in the pickle bath, while those films highly oxidized are more difficult to remove through normal pickling.

In reviewing some of the line speeds at the various pickles that we have studied, we can arrive at but one conclusion, namely; that the line speeds are such that we are overpickling vast tonnages of cold rolled sheets. Our acid concentrations and methods of cascading the pickling bath coupled with slow pickling speeds result in a pickled surface which although it appears clean to the naked eye is far from being so. Because of existing foundations, motor placements, etc.; very little can be done with some of these lines. Those lines which will replace the existing ones should be scrutinized for the elimination of any or all factors that could lead to the producing of an over-pickled surface.

We have conducted many trials in coil preparation prior to continuous pickling. These have all been aimed at compacting the surface of these coils and producing a thorough embrittled oxide film which could easily be pickled. Our results were the same in each case. The as-pickled surface was smoother and cleaner in appearance even though the plain as-hot-rolled coils were pickled at the same line speeds, and we judged the prepared coils to have been over-pickled. Subsequent chemical checks revealed the presence of lesser quantities of iron salts, free iron, carbon surface and other smudge conditions. We do feel that surface compacting or skin passing the coils prior to pickling assists in producing a cleaner less deeply etched surface because:

1. Skin passing helps to embrittle the oxide film rendering it more susceptible to the acid attack and consequential faster line speeds.
2. Skin passing by compacting the surface grains into the grain boundaries strengthens them by reducing the slip planes or fault lines to a smaller cross-sectional area with a higher resistance to acid impenetration.
3. This less deeply etched surface will carry over less pickle line contaminant and will result in cleaner surface.
4. The wipe tests conducted on tandem-reduced coils produced from skin-passed coils revealed the presence of lesser amounts of iron salts and free iron.
5. The action of sulphuric acid on the surface of the coils mentioned in 4 above results in a more uniform unilateral direction with a smoother cleaner surface.

In considering the reaction of the sulphuric acid with the oxide film on the coils, one must remember that the FeO portion is readily soluble in the acid, with the balance being considered less soluble. This latter part must be reduced, at least in part to FeO by the generated hydrogen gas which is an end result of the acid attack on part of the oxide film and the steel base. This reaction has often been described as being one wherein the FeO phase dissolves in the acid, the generated hydrogen "pops" off the rest of the scale. If this were so, we would never have any under pickled coils since all the scale, would be loosened. We fail to agree with such a description. The removal of this oxide film layer which we contend to be an admixture type gradient from FeO to Fe_2O_3 is likened to a reaction of a voltaic cell. The iron base acting as the anode and the Fe_3O_4 phase as the cathode results in a cell with the emf of 1.42 volts. With the Fe_2O_3 phase this is reduced to 0.47 volts and a slower pickling rate. Since this is an accepted fact, the electrochemical action proceeds at different rates over the surface of the coil, resulting in different pickled surfaces. The importance of producing coils with the right type of oxide film on carbon steel is one of prime importance for two basic reasons:

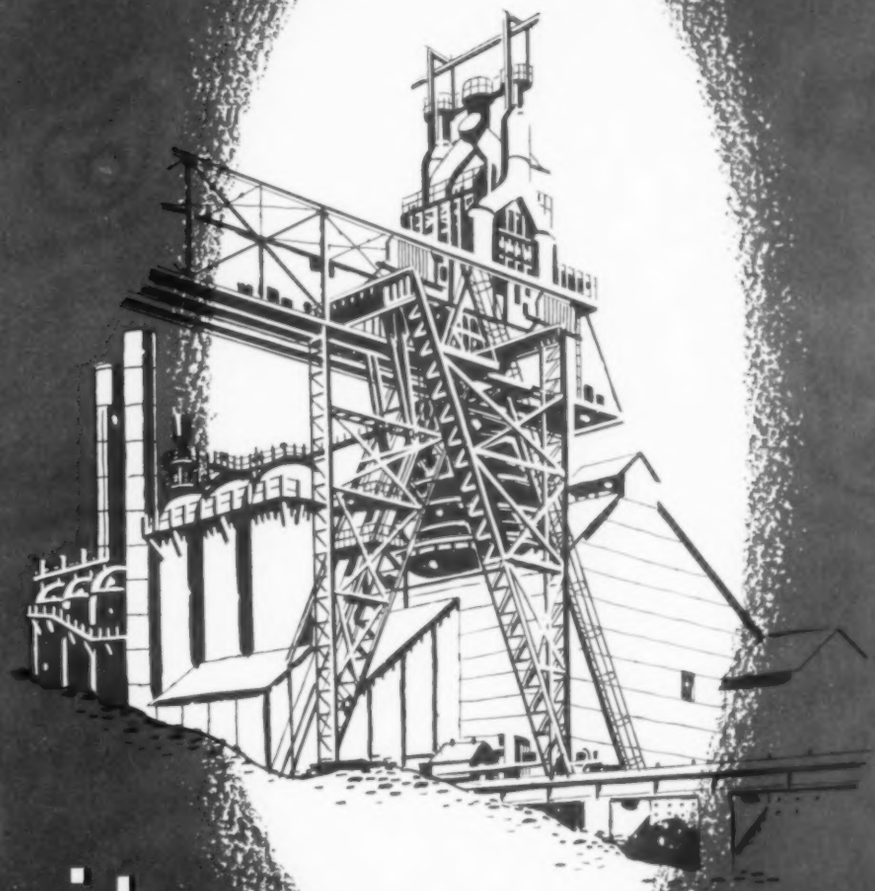
1. The temperature at which the steel is finished must be such so as to allow the minimum amount of interference in the formation of the body centered cube at temperatures of below 1600 F.
2. The finishing and coiling temperatures must be correlated so as to produce an oxide film layer extremely rich in FeO and with minimum of Fe_3O_4 and Fe_2O_3.

a. All rolling oils whether animal, vegetable or mineral undergo partial decomposition when contaminated with pickle line residues and resultant deposition of amorphous carbon on the surface of the steel.

b. Present day annealing practices using DX gas as the inert atmosphere are not conducive to the production of uniformly bright coils since a considerable amount of reduction and evaporation of surface contaminants cannot take place.

c. The most critical point during annealing is the temperature range of 750 to 932 F. During this interval, the oil must all be evaporated.

The control and/or reduction of smudge conditions on cold rolled sheets is not dependent on any one specific condition. We must consider all phases of our hot rolling, pickling and annealing practices, taking into consideration what conditions must be improved before any progress can be made in the right direction.



Detroit at Portsmouth

DSC

Detroit at Portsmouth

by T. J. Ess

▲ IN 1803 the town of Portsmouth, Ohio, was plotted at the junction of the Ohio and Scioto rivers. Subsequent discovery of iron ore, combined with virgin forests for the production of charcoal, led to the establishment of numerous blast furnaces and forges and the district became an important iron producing center.

In 1831, Portsmouth Iron Co. was incorporated, and built a rolling and slitting mill. Three years later this company failed and was bought by Thomas G. Gaylord, who remodeled the mill and for 38 years operated the plant as Thomas G. Gaylord & Co. Subsequently renamed the Gaylord Rolling Mill Co., the plant produced boiler plate, sheet iron, bar iron, rivets, cut nails and castings. Crucible steel facilities and an open hearth furnace were added.

After a nine-year period of lease to the Portsmouth Iron & Steel Co., the property was purchased by the Burgess Steel & Iron Works. When the plant was destroyed by fire in 1898, a new plant was built at New Boston, six miles up the Ohio River from Portsmouth. This plant included four 30-ton open hearth furnaces, a 28-in. bloomer, two plate mills and an 18-in. bar mill.

After passing through the hands of Crucible Steel Co. of America (1900), the company became Portsmouth Steel Co. (1902), was absorbed by Whitaker-Glessner Co. (1909), and adopted the last name (1915). Seven 60-ton open hearth furnaces were built and new bar, sheet and jobbing mills installed. A coke plant in 1916 and a blast furnace in 1917 completed integration of the plant.

In 1920, Whitaker-Glessner Co., La Belle Iron Works and Wheeling Steel and Iron Co. combined to form Wheeling Steel Corp. In 1946 the Portsmouth plant was sold to Portsmouth Steel Corp. and, four years later, was acquired by Detroit Steel Corp. This company has just completed a $90,000,000 expansion program

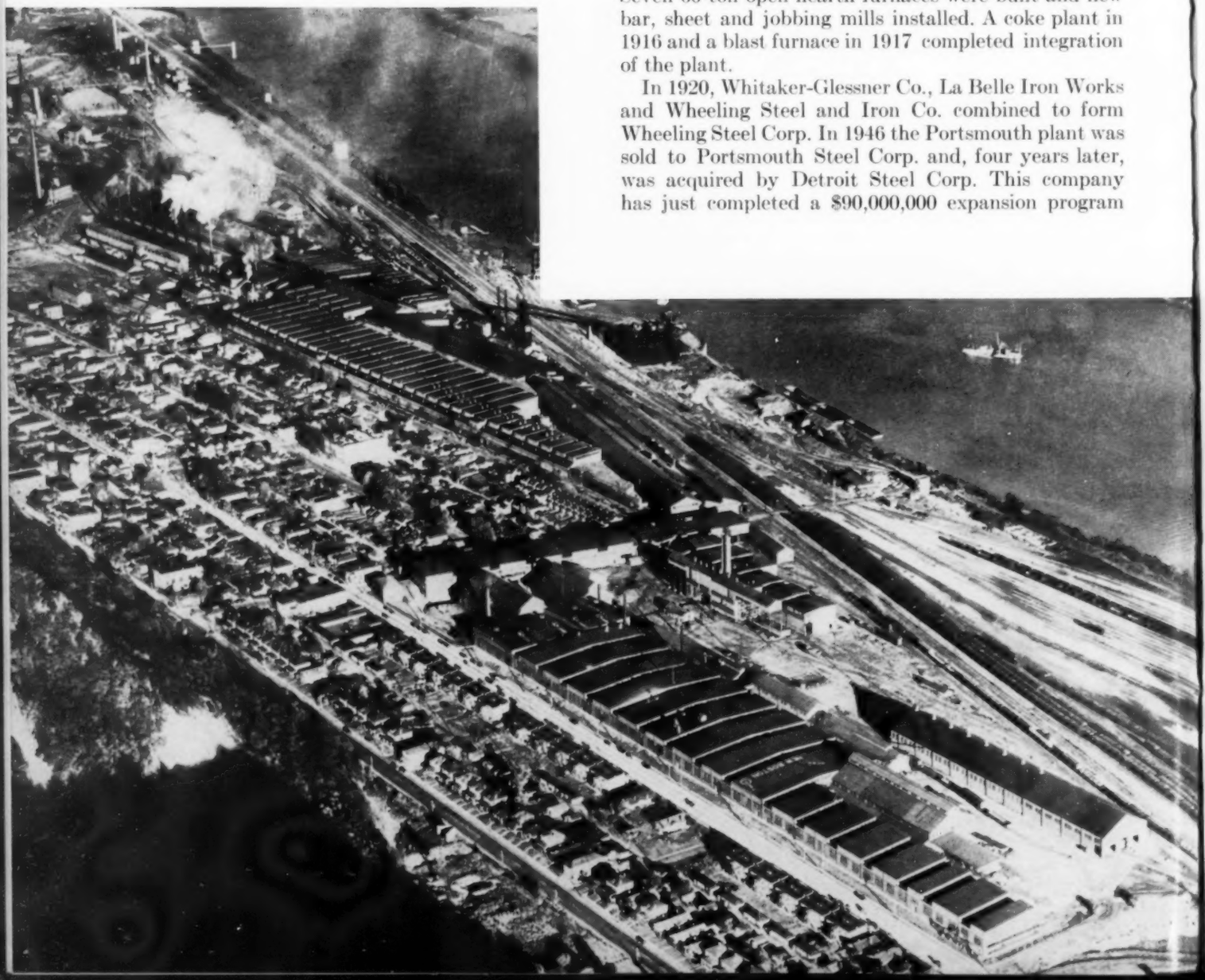


TABLE I
Iron Ore Analyses

	Seine River	St. Paul
Iron	53.0	50.0
Silica	6.0	9.5
Manganese	0.16	0.74
Phosphorus	0.024	0.08
Alumina	1.20	1.50

TABLE II
Coal Analyses

	High volatile	Low volatile
Volatile matter	33.40	16.60
Fixed carbon	59.40	77.10
Ash	7.2	6.30
Sulphur	0.64	0.72
Water	3.10	4.20

which has resulted in an integrated plant with modern production methods. On the 227-acre site are facilities for the annual production of 550,000 tons of coke, 768,700 tons of pig iron, 1,290,000 tons of basic open hearth steel, 900,000 tons of hot rolled strip and 210,000 tons of wire rod. Finishing facilities include equipment for 360,000 tons of cold rolled sheet. Wire rod goes into rods, manufacturers and high carbon specialty wire, galvanized wire and reinforcing fabric.

The Portsmouth plant also supplements the supply of hot bands for the company's cold strip mill at Detroit.

Iron ore for the blast furnaces is purchased and stems from the Mesabi and Atikoken ranges. It arrives at the plant by rail, is unloaded by a 90-ton stationary car dumper and hauled in 75-ton self-dumping cars to the blast furnace high line and put into storage.

The storage yard, 830 ft long x 230 ft wide, has a capacity for about 650,000 tons of ore. It is parallel and adjacent to the blast furnace high line, and is served by a 7½-ton bridge.

The ores have analyses averaging as shown in Table I. They are washed and graded at the mines and graded at the upper lake ports. No beneficiation is done at the plant. Consumption usually runs 1100 to 1300 gross tons of Seine River ore and 1700 to 1900 gross tons of St. Paul ore per day.

High volatile coal comes from the Pond Creek and Alma seams in company-owned mines at Freeburn and Stone, Kentucky. Low volatile coal, from No. 3 Pocahontas field, is purchased from several sources. Analyses of these coals average as shown in Table II.

Coal is received in hopper cars, unloaded into a track hopper, and conveyed on belts to the breaker house. For emergencies, some coal, to the extent of about 60,000 tons, may be stored on the ground between railroad tracks. This storage is stocked and reclaimed by bucket crane.

Daily coal consumption runs about 1600 net tons of high volatile and 500 net tons of low volatile.

Limestone is received in hopper cars and analyzes about as follows:

	Per cent
Lime	47.93
Magnesia	4.91
Silica	2.49
Alumina	0.22
Iron	0.69
Sulphur	0.014

Crushed to 4 x 1 in. and washed at the quarry, it is normally unloaded directly into the stock bins at the blast furnaces. Daily usage ranges 650 to 750 net tons.

M. J. ZIVIAN
President

H. V. CLARK
Executive Vice President

H. E. BAUGHMAN
Vice President-Operations

A. E. REINHARD
Gen. Superintendent

R. J. MC KEE
Chief Engineer

COKE PLANT

Two batteries of by-product coke ovens, each of 54 ovens, provide facilities for coking 2000 tons (2160 tons maximum) of coal per day. Coal is conveyed to two 150-ton per hr breakers, where it is crushed to minus 3 in. and elevated to three 200-ton mixing bins. From these bins, high volatile and low volatile coals are discharged in 77 to 23 per cent proportions, conveyed to a joint hopper, and then to two 150-ton per hr pulverizers, where it is pulverized so that 72 per cent passes through a $\frac{1}{8}$-in. screen. The fine coal is then carried to the oven bins, from where it is moved to the individual ovens by four-hopper, 16-ton charging larries.

The ovens, 36 ft long x 12 ft high x 19 to 21 in. wide, take a coal charge of 16 tons. They are heated by coke oven gas burnt in six horizontal flues in each oven wall. Oven doors are raised by cable and hydraulic hoists. With normal operation, 125 ovens are pushed per day. This may be increased to a maximum of 135 ovens per day if necessary.

Two pusher machines, with leveling bars and 16-in. x 11-ft pusher ram heads, push coke from the ovens into a 45-ft quenching car which is propelled by a 25-ton diesel engine. The quenching tower, 30 ft high, is constructed of transite sheets on a steel frame. Ammonia still waste is used for quenching.

Quenched coke is dumped on the 325-ft wharf and, after cooling, passes through gates to a 36-in. belt conveyor which carries the coke to a 6-in. scalping screen. Oversize coke is crushed to 5 in. or less.

All coke is then put over a $1\frac{1}{4}$-in. grizzly screen and a $\frac{3}{4}$-in. shaker screen. All coke $\frac{3}{4}$ in. and larger is loaded into hopper cars for use in the blast furnaces. Minus $\frac{3}{4}$-in. coke passes over a $\frac{3}{8}$-in. screen to form $\frac{3}{8}$ x $\frac{3}{4}$-in. nut coke and minus $\frac{3}{8}$-in. breeze. Nut coke is sold and in so far as possible, breeze is burned under boilers; excess breeze is sold.

Crude tar is removed from the gas by cooling, with the last traces removed by an electrostatic precipitator. The tar is then refined in a distilling plant to produce

Two batteries of coke ovens provide an annual capacity for 550,000 tons of coke. In the foreground is the high line for the blast furnaces.

road tar, roofing pitch, creosote, pitch coke and naphthalene.

Ammonia is absorbed by water scrubbers, forming a one per cent liquor which is then concentrated to a 30-per cent solution in ammonia stills.

Light oil is absorbed by a medium petroleum oil in the light oil scrubbers and then is separated from the wash oil by steam distillation. The light oil is then washed with sulphuric acid, neutralized with caustic soda solution and distilled in an 11-ring, 8000-gal column still to form benzol, toluol and xylol.

Coke produced has characteristics averaging about as follows:

	Per cent
Volatile matter	1.10
Fixed carbon	89.70
Ash	9.20
Sulphur	0.54
Moisture	4.00
Porosity	53.
Tumbler test	46.
Shatter test	72.

Coke yield runs about 72 per cent furnace coke, 2 per cent nut coke and 3 per cent breeze. By-product recoveries average 9700 cu ft of gas, 6.7 gal of tar, 3.65 lb of ammonia as aqueous ammonia, and 2.78 gal of light oil per net ton of coal coked.

About 44 per cent of the gas is used in heating the ovens. Surplus gas flows to a 200,000-cu ft holder, from which it is piped to the hot strip mill, the rod mill or to a mixing station where it is mixed with blast furnace gas to form a mixed gas for use in soaking pits. Daily usage of the mixed gas averages about 16,000,000 cu ft.

BLAST FURNACES

Two blast furnaces produce basic iron for use in the open hearth furnaces. Table III gives principal design and operating characteristics of the blast furnaces. No. 1 furnace was blown in on December 28, 1955, after a relining job which followed a remarkable campaign of ten years and three months. No. 2 furnace is a larger unit, blown in for the first time on August 27, 1953. The two furnaces set a production record of 63,981 net tons of iron in December, 1956.

The hearths of both furnaces are cooled by conventional cooling staves, 9 ft long in No. 1 furnace, 17 ft-11 in. long in No. 2. Crucibles and boshes of both furnaces are cooled by conventional bronze cooling plates, which are also carried 14 rows above the mantle in No. 1 furnace, 7 rows above in No. 2 furnace. Both stocklines are protected by special steel wearing plates.

Both furnaces are served by a common high line carrying three tracks, one for a transfer car, one for unloading ore, and one for miscellaneous purposes. Ore is reclaimed from storage by the ore bridge and is carried by transfer car to bins beneath the high line.

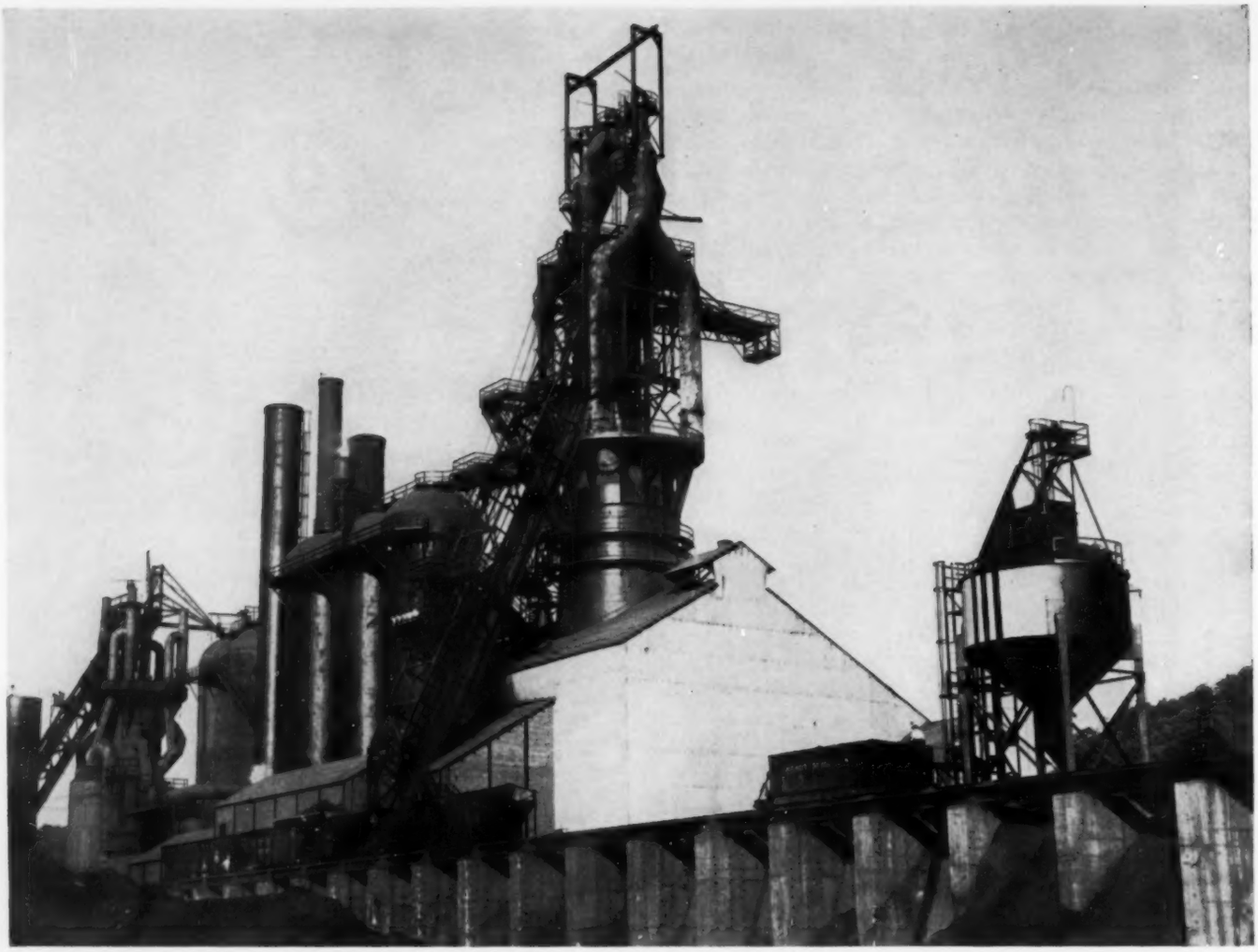
The new furnace has two 11,250-cu ft coke bins from which coke passes through double deck vibrating screens into weighing hoppers and thence into the skips. Ore and stone are stored in 21 double bins of 4750 cu ft capacity each. These bins have drum type gates.

TABLE III
Blast Furnace Dimensions

Furnace	No. 1	No. 2
Diameter of hearth, ft-in.	18-10	28-6
Diameter of bosh, ft-in.	22-8	31-3
Diameter of stockline, ft-in.	17-6	22-0
Height, iron notch to top platform, ft-in.	92-0	108-0
Height of crucible, ft-in.	10-6½	12-0
Height of bosh, ft-in.	11-4	10-3
Height of straight section, ft-in.	13-0	8-6
Height of inwall section, ft-in.	40-6	57-0
Height, stockline section to top ring, ft-in.	8-4½	8-3¾
Height, bottom to iron notch, ft-in.	1-3½	2-3
Height, iron notch to cinder notch, ft-in.	4-0	4-8
Height, cinder notch to tuyeres, ft-in.	3-6	4-2
Working volume, cu ft	24,022	48,065
Bosh angle, deg-min-sec	80-24-4	82-21-35
Inwall slope, in. per ft	0.765	0.974
No. of tuyeres	12	20
Tuyere diameter, in.	6	5½
No. of columns	6	10
Lining thickness, crucible, in.	27	36
Lining thickness, bosh, in.	27	28
Lining thickness, stack, in.	33	40
Lining thickness, throat, in.	37½	45
Big bell diameter, ft-in.	12-9	16-6
No. of stoves	3	3
Stove diameter, ft-in.	24-0	26-0
Stove height, ft-in.	110-0	123-6
Checker openings, in.	(2) 1 13/16 (1) 3	3
Heating surface per stove, sq ft	(2) 206,152 (1) 162,329	273,019
No. of turboblowers	2	1
Blower capacity, cfm	50,000	110,000
Blower pressure, psi	20	30
Steam to blower, lb per hr, average	48,000	68,000
Blast volume, cfm, average	48,000	80,000
Blast volume, cfm, maximum	50,000	110,000
Blast temperature, F, average	1020	1100
Blast temperature, F, maximum	1300	1400
Normal blast pressure at tuyeres, psi	15.8	22
Normal top pressure, in. of water	34	37
Normal top temperature, F	385	390
Lb of ore per net ton of iron	3550	3300
Lb of stone per net ton of iron	710	690
Lb of coke (dry) per net ton of iron	1700	1820
Lb of scrap charged per net ton of iron	None	35
Lb of open hearth slag charged per net ton of iron	340	336
Lb of roll scale charged per net ton of iron	None	102
Daily iron production, net tons, average	745	1400
Daily iron production, net tons, maximum	1060	1670
Lb of slag made per net ton of iron	982	938
Lb of flue dust made per net ton of iron	43	73
Ratio, stone to mix, per cent	18.3	17.7
Fuel ratio	2.22	2.04
Silica in mix, per cent	9.4	9.2
Theoretical yield, per cent	53.13	53.84
Actual yield, per cent	52.28	53.71

No. 1 furnace has 11 stock bins, each of 4200 cu ft capacity, and one coke bin.

The smaller furnace has a single skip of bucket type, operating under manual control. Both bells are hydraulically operated. The large furnace has a double skip under automatic control, and a revolving distributor top. This skip hoist is driven by two 150-hp mill type d-c motors which operate under adjustable voltage control. The skip cars operate at speeds up to 600 fpm. Bells are operated pneumatically, using air from the cold blast system or, in emergencies, compressed air.



No. 2 blast furnace, in the foreground, has a 28 ft-6 in. hearth and produces 1400 tons of iron per day. No. 1 furnace has an 18 ft-10 in. hearth and makes 745 tons a day.

Ore and limestone are charged by weight on both furnaces. Coke is charged by volume on No. 1 furnace, by weight on No. 2. Charging sequences are usually as follows:

No. 1 furnace	OC/OSC/
Every sixth round	CO/COS/
No. 2 furnace	OOSCC/

The new furnace is equipped with electric charging control and interlocks tying together the operation of the scale car, coke bin mechanism, skip hoist, distributor large and small bells, stock line recorder and stock watering valves. Thus, the various operations will occur only in the preselected sequence.

Blast from the turbo blowers listed in Table III is preheated in two-pass stoves of side combustion design. Blast temperatures are automatically controlled by mixer valves on both furnaces.

Cold blast piping is so arranged that the small blowers can provide blast for No. 2 furnace should anything happen to the single large blower. All blowers operate on 200-psi steam. The large unit is equipped with a surface condenser, the two smaller units with jet condensers.

The stoves are fired with clean blast furnace gas through proportioning pressure burners. Stove cycles are normally four hours on gas, two hours on blast. Waste gases at the stove stacks average about 350 F.

Gas leaves the top of each through four off-takes, 51 in. in diameter on No. 1 furnace, 60 in. in diameter on No. 2 furnace. On No. 1 furnace, the four off-takes are combined into two downcomers which merge near

Instrument panel board, No. 2 blast furnace.

the dust catcher. On No. 2 furnace, the four off-takes are combined into two up-takes which are in turn combined at the top of the furnace into a single downcomer.

Each furnace is provided with a dust catcher and a wet tower washer. Leaving the washers, gas from both furnaces is combined and passes through two 29-ft x 35 ft-4 in. electrostatic precipitators in parallel, each unit containing 240 12-in. tubes. Gas leaving the precipitator contains approximately 0.01 gr of dust per cu ft, and is used in the stoves and under boilers. Stoves use 27 to 30 per cent of the total gas, about 5 per cent is used in the soaking pits, and the remainder, except for a considerable amount bled, is used to fire boilers.

Effluent from the gas washers flows to a 90-ft diameter, 10,000-gpm thickener. Sludge is put into pits and, after drying, is moved to a stock pile.

Flue dust from the dust catchers passes through a pug mill and taken to stockpiles or to the high line bins for charging into the blast furnaces.

Both furnaces produce basic iron for the open hearths in analyses averaging as follows:

	Per cent
Silicon	1.22 –1.28
Sulphur	0.027–0.029
Phosphorus	0.194–0.225
Manganese	1.35 –1.78

Each furnace is tapped five times in 24 hours into 200-ton mixer type ladles and 75-ton open top ladles. When desired, iron may be put over a double strand pig machine, in which case iron in mixer ladles must be reladled into 75-ton open top ladles.

Slag from No. 1 furnace flows into ladles which are then dumped into pits. From No. 2 furnace, slag flows directly into pits adjacent to the furnace. An outside slag company digs slag from both pits and processes it for commercial uses.

Normal slag analyses run as follows:

	Per cent
Silica	37.2 –37.4
Alumina	10.9 –11.0
Calcium oxide	41.5 –42.4
Magnesium oxide	5.2– 5.8
Sulphur	0.85– 0.88
Iron	0.81– 0.83
Manganese	0.81– 1.21

OPEN HEARTH

An important part of the recent expansion program is No. 2 open hearth shop, containing four 250-ton furnaces and one 275-ton furnace. These furnaces are 87 ft-3 in. long x 24 ft-3 in. wide inside of the steel work, and are spaced on 110-ft centers. Hearth dimensions of the 250-ton furnaces are 53 ft x 16 ft-6 in., giving a hearth area of 805 sq ft with a bath depth of 36 in. The 275-ton unit has a bath length of 58 ft, giving an area of 938 sq ft with a bath depth of 34 in. Bottoms are made up of a thin layer of insulating concrete next to the pan plates, 9 to 12 in. of first quality firebrick, 9 in. of burnt chrome brick, 4½ in. of burnt chrome magnesite brick, 8½ in. of rammed material and 8 in. of grain magnesite.

Backwalls, with a slope of 57 degrees from the horizontal, are built of 13½ in. of plated unburned chrome-magnesite brick, covered by grain magnesite. Front walls are built of the same type of brick 18 and 13½ in. thick. The five charging doors are 5 ft-1 in. wide x 5 ft high.

The furnace roof, with a span of 25 ft 3¾ in. and a rise of 3 ft-4 in., is 15 in. thick with 18-in. ribs every fifth row. For distances of 6 ft along the backwall and 3 ft along the front wall, the roof thickness is increased to 18 in.

Port ends are of basic construction, 13 ft-6 in. wide x 11 ft-9¾ in. long. Port roofs are of suspended basic construction; and walls and port side walls are of burned chrome magnesite brick. Uptakes are 13 ft-6

No. 2 open hearth shop contains five modern furnaces which maintain a production rate of about 22.6 tons per furnace hour, tap-to-tap.

TABLE IV
Sectional Areas and Gas Velocities in Open Hearths

	250-ton furnace (600 gal oil per hr)		275-ton furnace (735 gal oil per hr)	
	Area, sq ft	Velocity, fpm	Area, sq ft	Velocity, fpm
Furnace centerline	162.0	12.3	162.0	15.0
Port knuckle	77.0	25.7	77.0	31.4
Port at downtake	70.6	28.0	70.6	34.2
Downtake	119.2	16.4	83.0	28.7
Regenerator bridge wall	80.0	24.9	97.3	25.0
Over first pass checkers	121.0	16.5	121.0	20.1
First pass checkers	168.2	10.2	168.2	12.4
Under first pass checkers	94.5	17.1	111.2	17.7
Idle pass	53.5	29.4	61.2	31.5
Over second pass checkers	98.8	15.9	118.5	16.3
Second pass checkers	107.0	12.7	107.0	15.5
Under second pass checkers	60.2	19.1	77.4	18.2
Stack flue	59.5	20.6	59.45	25.7
Stack	44.2	27.1	44.2	33.3

in. wide x 8 ft-10½ in. long, except on one new furnace where uptakes are 6 ft-2 in. long. Slag pockets are 16 ft long x 20 ft wide.

Regenerators in the new shop are of two pass design, with the first pass 17 ft-1½ in. x 19 ft-9 in., containing 16 ft-1½ in. depth of checkers. The second pass, 11 ft x 19 ft-9 in., has checkerwork to a depth of 17 ft-3 in. The idler flue between the two passes is 3 ft-1½ in. wide (3 ft-6 in. on the 275-ton furnace) and is divided into four flues about 4 ft long. Checkerwork flues are 7½ in. square.

Cross-sectional areas and calculated gas velocities at various points in the new furnaces are given in Table IV.

Water cooled artillery type burners introduce fuel oil and natural gas through the furnace ends. Natural gas at pressures up to 20 psi flows from the burners above the steam-atomized oil stream. Burners have a capacity for 950 gal of oil per hr, and will handle enough gas to make up about 40 per cent of the total fuel input. Average gas use, however, runs only about 10 per cent of the total fuel.

Air for combustion is supplied to each furnace by a 26,500-cfm, 4½-in. static pressure fan.

Bunker C fuel oil comes to the plant principally by river barge and is pumped from the unloading dock to storage tanks. Two 1,250,000-gal tanks serve No. 2 open hearth, and two 750,000-gal tanks serve No. 1 shop. Each shop has two oil circulating pumps rated at 3000 gpm, 175 psi. Some oil may also be received by tank cars and trucks.

Oil is heated in central heaters in each shop.

Each furnace in No. 2 shop is equipped with a complete layout of instruments and controls, including total Btu regulator, fuel-air ratio control, steam flow and pressure recorders, furnace pressure control, automatic reversal equipment, roof temperature recorder, checker temperature and a bath immersion thermocouple. All instruments and controls for each furnace are mounted on a control panel.

The furnaces in No. 2 shop are charged with scrap and hot metal in proportions of about 45:55 per cent. A typical charge consists of 18,500 lb of limestone, 45,000 lb of ore, 245,000 lb of scrap and 340,000 lb of hot metal. Heats of 270 tons are produced in approximately 12 hr, tap-to-tap, giving a production rate of about 22.6 tons per furnace hour. Fuel consumption averages 3,086,000 Btu per net ton of ingots. A little oxygen (about 25 cu ft per ton of ingots) is used for decarburization.

The stockyard for No. 2 open hearth shop has four elevated tracks, two for incoming cars and two for trains of charging buggies. Approximately 8000 tons of scrap can be stored here. Abutting this scrap storage, which is 440 ft long, are four 55-ft storage bins for limestone and ore.

The original open hearth shop (No. 1) at this plant

General plan of Portsmouth plant.

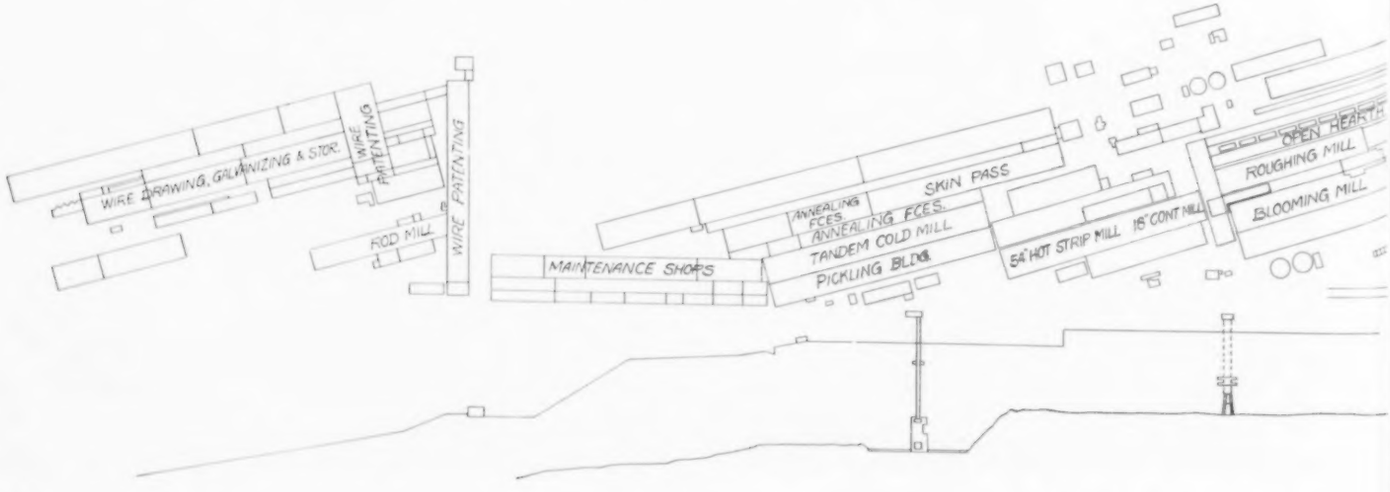


TABLE V
Open Hearth Buildings and Cranes

	Length, ft-in.	Width, ft-in.	Cranes		
			No.	Capacity, tons	Span, ft-in.
No. 2 shop					
Stockyard	660–0	90–0	2	15	85–0
Lean-to	715–0	59–11	...	.....	...
Charging bay (charging machines)	715–0	87–1	1	150/35/15	80–0
			2	10	27–0
Pouring bay	660–0	85–0	2	350/60/20	76–0
Mold yard	577–6	78–0	1	25	72–0
Stripper building	330–0	114–0	1	400	107–0
No. 1 shop					
Stockyard	560–0	63–0	3	5	60–0
Charging bay (charging machines)	770–0	60–0	3	5	11–0
Pouring bay	770–0	40–0	2	150/25	37–0
Mold yard and stripper	140–0	39–0	1	150/7.5	37–0
Old stripper	120–0	40–0	1	150/7.5	37–0

consists of ten 100-ton furnaces with hearths 41 ft long x 14 ft-6 in. wide. These furnaces take a typical charge of 115,000 lb of scrap, 115,000 lb of iron (hot and cold), 20,000 lb of limestone and no ore.

Operating with about 39 per cent hot metal, the furnaces in No. 1 shop turn out 100-ton heats in 14.5 hr, tap-to-tap, for a production rate of 6.5 tons per furnace hour. Fuel consumption averages 5,900,000 Btu per ton.

All steel produced is of carbon grades ranging 0.03 to 0.87 per cent carbon content, rimmed and killed. Both open hearth shops make all grades, but since No. 1 shop is limited in the size of ingots it can handle, most of the ingots for strip production are made in No. 2 shop.

Steel is poured into molds of several sizes and types: big-end-down slab ingots 22 x 54 x 70 in., 26 x 48 x 70 in., 26 x 42 x 70 in., 26 x 36 x 70 in., 24 x 30 x 70 in., hot-topped big-end-up ingots 22 x 24 x 72 in., and bottle-top ingots 24 x 48 in. and 24 x 52 in. Prior to pouring, molds are sprayed with a graphite base material.

Slag volume is varied as needed to insure low phosphorus and sulphur. A lime-to-silica ratio of about 3:1 is maintained. Open hearth slag is taken to a skull-cracker where it is processed and screened for use in the blast furnaces. The waste is moved to the slag dump.

Miscellaneous equipment in No. 2 shop includes a stopper rod oven, a stopper rod press and two dolomite machines.

No mixer is installed in either shop. At No. 2 shop, hot metal is poured from the mixer-type iron ladles into transfer ladles as needed, and taken directly to the furnaces. At No. 1 shop, hot metal is brought to the furnaces in a special 30-ton transfer ladle car which is filled by reladling from mixer-type ladles.

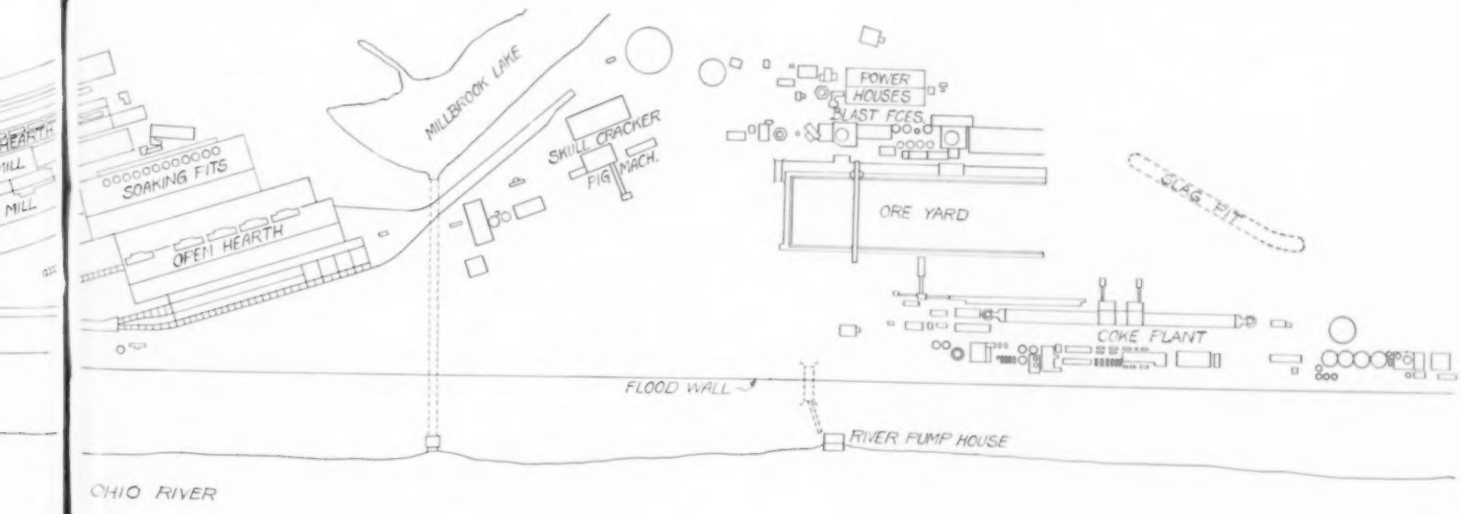
Oxygen for decarburization (as well as for burning scrap and for general maintenance) comes from a liquid conversion plant of 100,000 cfhr capacity. Consumption from the plant totals about 6,000,000 cu ft per month. For decarburization, oxygen is introduced through a one-in. pipe lance, using about 25 cu ft of oxygen per ton of ingots.

In March, 1956, the open hearth shops set a production record of 93,644 net tons of ingots.

BLOOMING MILL

The blooming mill, another unit of the recent expansion program, is a 44-in. unit and was first put in operation in February, 1954.

Ingots are heated in 12 circular soaking pits 18 ft in diameter at the throat, 22 ft-9 in. in diameter at burner level, and 9 ft deep. Each pit is equipped with ten tangential combination burners. Fuel may be a mixture of coke oven gas and blast furnace of 100 to 160 (usually 140) Btu per cu ft calorific value, equivalent mixture of natural gas and air, or fuel oil, with the preference in the order of listing. This variety of fuels



Twelve circular soaking pits, fired through tangential combination burners, heat ingots for the blooming mill. The pits are equipped with metallic recuperators.

affords a high degree of flexibility and insures continuity of operation in cases of interrupted supplies of blast furnace gas and natural gas.

Air for combustion is preheated to about 1050 F in metallic needle-type double-pass recuperators. The first pass contains 36 elements of 30 per cent chromium cast alloy; the second pass has 27 cast iron elements. Combustion air is forced through each recuperator by a 7400-cfm, 12-oz blower. Combustion products leave each pit through a 4-ft diameter port in the center of the pit bottom, and are carried through a flue to the recuperator. Recuperator elements are protected from excessive temperatures by diluting the gases with air. Inlet temperatures are limited to 1750 F, and exit gas temperatures average about 900 F. The exit gases are collected by flues and carried to one of three stacks.

Each pit is provided with automatic control on fuel-air ratio, furnace pressure, furnace temperature and recuperator temperature. Recording instruments provide a history for these factors as well as for Btu input. These instruments and controls, together with the essential switches and signal lights, are mounted on a control panel for each pit. Four of these panels are located in each of three glassed-in, pressurized control houses.

Ingots charged into the pits may range from cold to 1800 F. Heating times accordingly vary, running about twice the track time. With cold steel, each pit will heat about 10 tons per hr. Fuel consumption averages approximately 1,180,000 Btu per net ton of ingots charged.

Pit operation follows "dry-bottom" practice. At the start, pit bottoms were filled with 12 in. of clean mill scale. Each month, 2 to 4 in. of scale was added. At present, bottoms of dolomite, topped by crushed magnesite brick, are used. Bottom life averages 6 to 9 months.

The pits are arranged in a single row ahead of the

The blooming mill, a 44-in. two-high, high lift unit, averages 200 tons per hour on slabs, 100 tons per hour on blooms.

mill on a center line about 35 ft from the paralleling mill line. Pit covers are handled by two 25-ton cover cranes.

Ingots coming from the open hearth are stripped by a 400-ton stripper crane in the east end of the pit building. Two 25-ton pit cranes handle ingots into and out of the pits. A remotely controlled transfer buggy, traveling at speeds up to 800 fpm, carries the heated ingots to the mill.

The blooming mill is a 44-in. high lift, two-high, reversing stand designed to roll slabs 18 to 50 in. wide and 4 to 9 in. thick, and blooms from 6 to 10 in. square, from ingots ranging from 26 x 54 in. (22,000 lb) to 22 x 24 in. (9000 lb).

The mill uses cast alloy steel rolls 44 in. in diameter x 110 in. body length, with a 62-in. bullhead and 14-, 8- and 6-in. passes. Roll necks run in water-lubricated composition bearings.

The top roll, which is hydraulically balanced, is moved up and down by 15-in. screws of 2-in. pitch, working in bronze screw boxes and driven through worm reducers by two 150-hp mill type motors under adjustable voltage control. The mill is designed for a maximum roll opening of 60 in., and a maximum lift speed of 400 in. per min is available. Housing posts have a cross-sectional area of 540 sq in.

The mill is driven by a twin drive consisting of two 4000-hp, 40/100-rpm, 900-volt, single armature d-c motors, each motor driving one roll through spindles 20 in. in diameter and 30 ft long. This drive has a torque rating of 1,050,000 lb-ft for continuous operation, and 2,887,000 lb-ft maximum.

The drive motors receive power from a motor-generator set consisting of four 1600-kw, 450-volt, d-c

This view of the blooming mill runout shows the shear, crop conveyor (left), slab piler (center), and bloom conveyor (right).

generators, a 164-in., 108,000-lb steel plate flywheel (195,000 hp-sec at 514 rpm), and a 7000-hp, 11,000-volt, 3-phase, 60-cycle, 514-rpm, wound-rotor induction motor. The generators are cross-connected, with two generators in series serving one main drive motor.

Main drive motors, motor-generator sets, control and switchgear for the blooming mill are housed in a pressurized motor-room provided with a down-draft recirculating ventilating system.

Ingots being rolled are lined up and turned by manipulators, with a pair of sideguards on each side of the mill. The left and right sideguards are each driven by two 150-hp mill type motors under adjustable voltage control. Fingers to turn the ingot are installed only on the entry side of the mill.

Mill tables are of heavy construction. The ingot receiving table is 29 ft-3 in. long and contains a scale and ingot turn-around. The ingot next moves over a 22 ft-6 in. intermediate table. Front and back mill tables are each 25 ft-10 in. long and consist of 12 rollers 20 in. in diameter x 110 in. long. Each mill table is driven by two 150-hp mill type motors under adjustable voltage control. Speeds up to 450 fpm are available. A pair of feed rollers is installed on each side of the mill, each pair driven by a 50-hp mill type motor, also under adjustable voltage control. Following the back mill table are the intermediate delivery table, 22 ft-6 in. long, and the shear approach table 49 ft-6 in. long.

Except for the main front and back tables, the tables are driven at speeds up to 433 fpm by mill type motors under constant potential.

Ingots leaving the mill move over the tables to the shear, 115 ft distant. This shear is rated at 1200 tons and will cut hot steel in sections up to 6 x 50 in. It is driven by two 350-hp mill type motors operating under adjustable voltage control. The shear has a screw type, motor-driven shear gage that will measure lengths of 6 to 22 ft. Crops fall into a pit from which an inclined conveyer moves them into another pit. From here they are loaded into railroad cars by magnet and overhead crane.

Scale falling through the tables is flushed into a scale pit, from where it is removed by grab bucket and loaded into hopper cars.

Power for the adjustable voltage auxiliaries comes from two 7-unit motor-generator sets, each driven by a 1250-hp, 2300-volt, 80 per cent power factor synchronous motor. The generators serve the various auxiliary drives as follows:

Ingot buggy	Two 100-kw generators
Mill tables	Two 300-kw generators
Feed rollers	Two 50-kw generators
Manipulators	Two 150-kw generators
Screwdowns	Two 150-kw generators
Shear	Two 350-kw generators

Three circulating oil systems serve the blooming mill. One, of 350-gal storage capacity, 10-gpm circulation, lubricates the slab shear. Another, of 200-gal storage capacity, 10-gpm circulation, serves the mill screwdown. The third, of 250 gal storage capacity, 10 gpm circulation, serves the slab tilting table.

Four automatic grease systems lubricate mill tables, manipulator, the mill proper, and miscellaneous points. Ten manual grease systems serve miscellaneous auxiliaries.

From the shear, slabs may move straight ahead approximately 40 ft to a slab piler, from where a transfer car moves them to storage or to the scarfing beds. Blooms may move straight ahead for transfer to storage

or they may be carried over a transfer to the tables of the billet mill.

This mill rolls at speeds up to 1000 fpm and averages about 200 tons per hr on slabs and 100 tons per hr on blooms. The rolling rate is limited somewhat by soaking pit capacity, but the mill has rolled as much as 1500 tons per 8-hr turn, 4000 tons per day and 80,498 tons per month. The product is about 75 per cent slabs, 25 per cent blooms. Power consumption of the mill averages 17 kwhr per ton rolled.

Soaking pit capacity will be increased during 1957 with the erection of two batteries (two holes each) of rectangular soaking pits. These pits will have inside dimensions of 8 ft-6 in. width by 22 ft length, and will be 13 ft-6 in. deep from top of curb to bottom brick. Each pit will have a nominal capacity of 75 tons, based on present ingot weights. Each pit will be equipped with a hot air type burner with hot air butterfly valves. These burners will be designed to use mixed coke even and blast furnace gas, or straight coke oven gas.

Each hole will be equipped with a metallic needle-type recuperator arranged with quick connected hot and cold air piping for easy removal and maintenance cleaning.

Spare recuperator elements will be provided so that any one of the recuperator elements in service may be removed for maintenance or cleaning purposes, and the spare inserted in its place in order to hold downtime to an absolute minimum.

Each hole will be equipped with an individual cover operating mechanism which will take the cover from the pit into the lean-to building.

The pits will be equipped with fully automatic controls, set up to meter maximum fuel input of 30,000,000 Btu per hr.

Another improvement now under way is the installation of an automatic four-side hot scarfing machine in the blooming mill. This machine will automatically scarf slabs in the size ranges from 6 to 53 in. in width, and from 2½ to 14 in. in thickness.

Installation of this equipment involves the construction of a complete fume exhaust system, a recovery water system in order to utilize waste water from the open hearth for the removal of slag, and construction of an acetylene plant with four acetylene generators.

The scarfer will be installed between the mill and the shear at a distance from the shear which will permit the entire slab to be scarfed before it is cropped. It is anticipated that the use of this machine will materially improve the surface condition of slabs by removing such imperfections as heavy rolled-in scale, slivers and surface scabs. Certain other types of defects will, of course, require some hand scarfing.

BAR AND BILLET MILLS

Blooms to be further reduced in the bar and billet mills usually come from the blooming mill in 7 x 8 in. sections. They are usually rolled down to 4¾-in. squares in a 24-in. three-high stand driven at 90.5 rpm by a 3000-hp, 11,000-volt, 514-rpm synchronous motor. During this rolling, the steel is manipulated by guides and a kick apron on the exit side raises the steel to the upper pass line for the return passes.

Table VI gives details of this mill.

In line with the 24-in. stand, some 215 ft away, is

TABLE VI

Bar, Billet & Rod Mill Data

Stand	Roll size, in.		Distance from preceding stand, ft-in.	Motor hp	Motor rpm	Gear ratio	Roll rpm	Roll speed, fpm
	Diameter	Body length						
Bar & Billet Mill								
Rougher (3-high)	24	54	....	3000	514	5.68	90.5	570
No. 1 finisher	18.25	27	215-10¾	..	...	3.62	22.32	104
No. 2 finisher	18.75	27	10-0	..	...	2.79	28.83	137
No. 3 finisher	18.75	27	15-0	5000	450	1.92	41.97	198
No. 4 finisher	18.75	27	10-0	..	...	1.72	58.71	278
No. 5 finisher	18.75	27	10-0	..	...	0.979	82.21	386
No. 6 finisher	18.25	27	10-0	..	...	0.731	110.0	520
Rod Mill								
No. 1 rougher	12	18	....	..	...	20.629	9.69/19.39	
No. 2 rougher	12⅛	18	5-0	..	...	13.448	14.88/29.76	
No. 3 rougher	12⅛	18	4-6	..	...	8.891	22.49/44.99	
No. 4 rougher	12⅝	18	3-10	2800	200/400	6.602	30.29/60.58	
No. 5 rougher	12¾	18	3-8	..	...	4.664	42.85/85.71	
No. 6 rougher	12⅞	18	3-8	..	...	3.444	58.07/116.14	
No. 7 rougher	13	18	3-8	..	...	2.499	80.00/160.00	
No. 8 intermediate	9⅞	18	20-0	..	...	1.46	137.0/274.	
No. 9 intermediate	10¼	18	3-3	..	...	1.109	180.35/360.7	
No. 10 intermediate	10⅜	18	3-0	..	...	0.877	228.0/456	
No. 11 intermediate	10⅜	18	2-9	..	...	0.708	282.35/564.7	
No. 12 prefinishing	11 7/16	18	23-6	800	320/700	1.177	271.6/594.34	
No. 13 prefinishing	11½	18	3-0	..	...	0.977	327.2/716	
No. 14-R finisher	10	18	28-0	..	...	0.694	460.6/1008	
No. 15-R finisher	10½	18	2-5	800	320/700	0.625	511.8/1120	
No. 16-R finisher	10 11/16	18	3-0	..	...	0.554	577.2/1263.4	
No. 17-R finisher	11⅛	18	2-5	..	...	0.518	617.8/1351.8	
No. 14-L finisher	10	18	28-0	..	...	0.694	460.6/1008	
No. 15-L finisher	10½	18	2-5	..	...	0.625	511.8/1120	
No. 16-L finisher	10 11/16	18	3-0	800	320/700	0.554	577.2/1263.4	
No. 17-L finisher	11⅛	18	2-5	..	...	0.518	617.8/1351.8	

an 18-in. continuous billet train, consisting of six two-high stands, all driven through a speed reducer, line shaft and bevel gearing by a 5000-hp, 2300-volt, 450-rpm induction motor.

The 24-in. mill uses babbitted roll neck bearings, while the 18-in. train is equipped with composition bearings. The rolls in all stands are adjusted manually, top and bottom. Two oil circulating systems and two grease systems provide lubrication for the principal points in both mills.

Preceding the 18-in. train is a crop shear, and a 30-in. steam driven flying shear is installed on the delivery table.

The 18-in. mill takes steel from the 24-in. stand, reducing the 4¾-in. squares to $1^{13}/_{16}$ or 2-in. squares. These are usually cut into 31-ft lengths for use in the rod mill. Production ranges between 75 and 90 tons per hr. Power consumption averages 22 kwhr per ton for main drives and auxiliaries.

Leaving the mill, billets are carried by roller table to two cooling beds 32 ft wide x 80 ft long.

ROD AND WIRE DEPARTMENT

Wire is an appreciable item in the output of the Portsmouth plant. Rod for the production of wire comes from a rod mill installed in 1922. This mill is currently producing coiled rod $^{7}/_{32}$ to $^{17}/_{32}$ in. in diameter.

Rod mill billets, usually $1^{13}/_{16}$ in. square (2-in. square maximum), 31 ft long, and 340 to 400 lb in weight, are delivered by railroad car from the billet mill previously described. They are heated in a side-charge, side-discharge continuous furnace 30 ft-3½ in. long x 32 ft-3 in. wide, rated at 30 tons per hr. The furnace is fired with natural gas, coke oven gas or fuel oil, according to the available supplies. Automatic controls are provided for furnace temperature, furnace pressure and fuel-air ratio. Heating time is about 45 minutes and fuel consumption averages 2,000,000 Btu per ton.

As a heated billet is pushed from the furnace, it first passes through seven roughing stands driven through gearing by a 1435/2870-hp, 600-volt, 200/400-rpm d-c motor. A steam-operated flying shear between stands No. 6 and No. 7 divides the billet as desired. The steel then passes through a group of four intermediate stands driven by the same motor that drives the roughers, and then through two prefinishing stands which are driven by one 363/800-hp, 600-volt, 320/700-rpm, d-c motors. All of these stands are in line.

From the prefinishing stands the rod may be diverted to either of two four-stand finishing trains located about 10-ft to the right and left of the roughing line. Each of these trains is driven by an 800-hp, 600-volt, 320/700-rpm d-c motor. Rod leaves the last finishing stand at speeds up to 4200 fpm and is conducted to one of six laying reels or two pouring reels. Here the coils are sprayed with water from two 1000-gpm, 100-psi pumps.

Details of the rod mill are given in Table VI.

Power for the four main drive motors of the rod mill comes from a set composed of two 1500-kw, 600-volt, d-c generators driven at 600 rpm by a 4200-hp, 2300-volt synchronous motor.

The rod mill operates with delivery speeds up to 4200 fpm, and averages about 25 tons per hour.

Looping troughs are installed ahead of the prefinishing stands and ahead of the finishing stands.

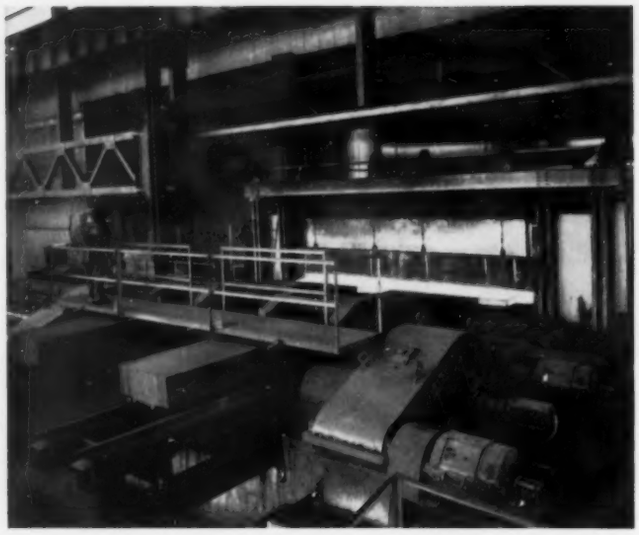
Coils are ejected from the reels on to chain-type conveyors 140 ft long x 5 ft wide, which carry them to a hook-type cooling conveyor 700 ft long.

The mill uses a combination of pass sections in the following sequence: box pass, box pass, square, oval, square, oval, square, oval, diamond, diamond, square, oval, round, oval, round, oval, round. An overfeed repeater is located between stands No. 10 and No. 11, and an underfeed repeater between stands No. 12 and No. 13.

Mill rolls are chill iron. Roll necks run in composition bearings, lubricated with water. Bottom rolls are adjusted manually through 2½-in. adjusting screws of ½-in. pitch. Circulating oil systems provide lubrication for the mill drives and reels.

Mill production averages 25 tons per hr, but this will go to 35 tons per hr with the heavier sections. Power consumption averages 65 kwhr per ton for the main drive and auxiliaries.

Except for heavy gages (above 0.148 in.), continuous multi-pass drawing machines are used to produce a wide range of grades and sizes of wire.



Entry end of slab heating furnace, showing double pusher.

A heavily constructed bumper absorbs the shock of the heated slab as it slides down the chute at the discharge end of the furnace.

Monthly production of the rod mill is about 15,000 tons of coiled rod, of which about 22 per cent is sold as rod, 33 per cent is finished into high carbon wire, and 45 per cent is finished into low carbon wire. About 40 per cent of the last category is made into a reinforcing fabric.

A complete layout of equipment is provided for the various processes in finishing wire according to type and product. After rolling, high carbon rod is patented in two continuous lines with lead bath quenching tanks following the furnaces.

All rod is pickled in coil form, then rinsed and dipped into a solution of lime or borax, and finally baked. Coils are then moved by ram trucks to the drawing machines.

Drawing facilities include 16 continuous multi-die machines (3 to 7 holes) for drawing wire from 0.225 in. down to 0.062-in. diameter; ten machines for drawing wire through six dies continuously to diameters between 0.023 and 0.062 in., and six 4- to 5-pass machines for drawing wire to diameters of 0.148 to 0.080 in.; 108 single block benches and one bull block for the heavier gages.

Heat treating facilities include two cylindrical annealing covers heated by natural gas burned in radiant tubes, and two oil tempering lines containing lead heating baths, muffle furnaces, oil quenching tanks, and lead drawing baths.

Wire may be galvanized in four lines containing lead baths, acid cleaning tanks and spelter pans.

Welded reinforcing fabric is made by four machines which form the fabric in rolls or in sheet sections, from wire ranging 0.135 to 0.362 in. in diameter. This department will be expanded in 1957 by the installation of a new welded wire fabric machine that will permit the manufacture of a mat 156 in. wide between centers of outside longitudinal wires, with clearances for an additional 6-in. overhang on each side.

The range of wire spacing of the new machine will be 2 in. minimum with spacing increments of 1 in. for any dimension above 2 in. The cross wire spacing will be 1 in. minimum up to 16 in. maximum. The size of the longitudinal wires will be No. 6 gage (0.192 in.) minimum to ½ in. diameter maximum. The size of cross wires will be No. 8 gage (0.162 in.) minimum to No. 2/0 (0.331 in.) maximum. The maximum number of longitudinal wires will be 79, and outside diameter of coiled fabric will be 60 in. with the inside diameter varying from 10 to 17 in. as desired.

The machine will be equipped with a flat sheet piler designed to pile sheets from a minimum size of 3 ft wide by 15 ft long, to a maximum size of 14 ft wide by 30 ft long. The machine will be equipped with 80 welding electrode assemblies spaced at 2-in. centers and forty 40-kva welding transformers. Three 600-kva adjustable voltage auto-transformers will be provided with suitable tap changer devices for controlling heats.

Welding control will be of an electronic type using tube contactors and phase shift heat control.

The machine will be equipped with side trimmer, slitter, shear, piler and winding reel, so that coiled or flat sheets of any width can be taken from machine as the demand indicates.

Speed range of the machine will be adjustable from 25 to 55 operations per minute.

The winding reel will be equipped for two-speed operation so that, when the fabric is cut to finish the proper size and weight of coil, the reel can be wound up quickly to provide time to remove the coil from the mandrel while the fabric machine continues to operate.

STRIP MILL

The 54-in. hot strip mill, which went into operation in 1952 with four finishing stands, was modified early in 1957 by the addition of two more stands in the finishing train. It is designed to reduce slabs 18 to 51 in. wide, 4 to 7½ in. thick, 114 to 240 in. long and 3700 to 22,000 lb in weight to strip 18 to 50 in. wide and 0.074 to 0.250 in. in thickness.

Almost all of the slabs coming from the blooming mill are put into storage and scarfed before rerolling into strip. Only about one per cent of the slabs are rolled direct from the bloomer. From storage, which has capacity for about 40,000 tons, slabs are carried by overhead crane to the 192-ft furnace charging table. A double ram pusher moves slabs through each furnace.

This vertical edger, with a two-high stand directly behind it, forms the reversing rougher of the hot strip mill.

Heating facilities at present consist of two continuous triple-fired furnaces 82 ft-6-in. long over-all, with hearths 70 ft long x 22 ft wide. One furnace is rated at 75 tons per hr, the other at 90 tons per hr. The higher capacity of the second furnace is obtained principally from higher Btu input, harder driving, and higher air preheat. The furnaces are fired with natural gas, coke oven gas or fuel oil. Each of the three firing zones has individual controls on fuel input and fuel-air ratio, while automatic temperature control is provided for the main heating zone and the soaking zone. Furnace pressure is also automatically controlled.

The furnaces are completely insulated and steel encased. Roofs are of suspended flat arch construction.

One furnace has a recuperator formed of silicon carbide tubes, with 189 tubes in each of two banks providing 2180 sq ft of heating surface. This unit heats air to 450 or 500 F. The air is pulled through the recuperator by a fan rated at 67,250 cfm, 4.82 in. pressure, 600 F.

The other furnace has a single pass metallic needle-type recuperator with 60 elements in each of three banks providing about 4,200 sq ft of heating surface. Cold air is heated to temperatures of 650 to 700 F as it is pushed through this unit by a 40,000-cfm, 12-in. static pressure.

Products of combustion enter the recuperators at temperatures of 1700 to 1950 F, and leave at 1200 to 1500 F. Fuel consumption averages 2,200,000 Btu per ton of slabs heated.

Heated slabs are expelled from the furnaces by action of the furnace pushers and slide down chutes to the mill table where spring bumpers absorb the impact. Passing over the furnace table and the approach table, totaling some 330 ft in length, the slab comes to the hot strip reversing rougher, details of which are given in Table VII.

The reversing edger and rougher are synchronized in an adjustable drive system, and the screwdown drive works under a preset automatic control system. Five or seven passes are used to break down the slabs for the finishing train.

From the roughing stand, the steel travels over mill tables to the finishing train 364 ft-6 in. away. This table is composed of rollers on 3-ft centers, driven in sections through line shafts by motors under constant potential control. A crop shear is provided ahead of the finishing train.

Loopers, acutated by d-c torque motors and controlled manually or automatically from load relays, are installed at the entry side of stands No. 2, No. 3, No. 4 and No. 5, A 20-kw, 60-volt motor-generator set serves the looper motors.

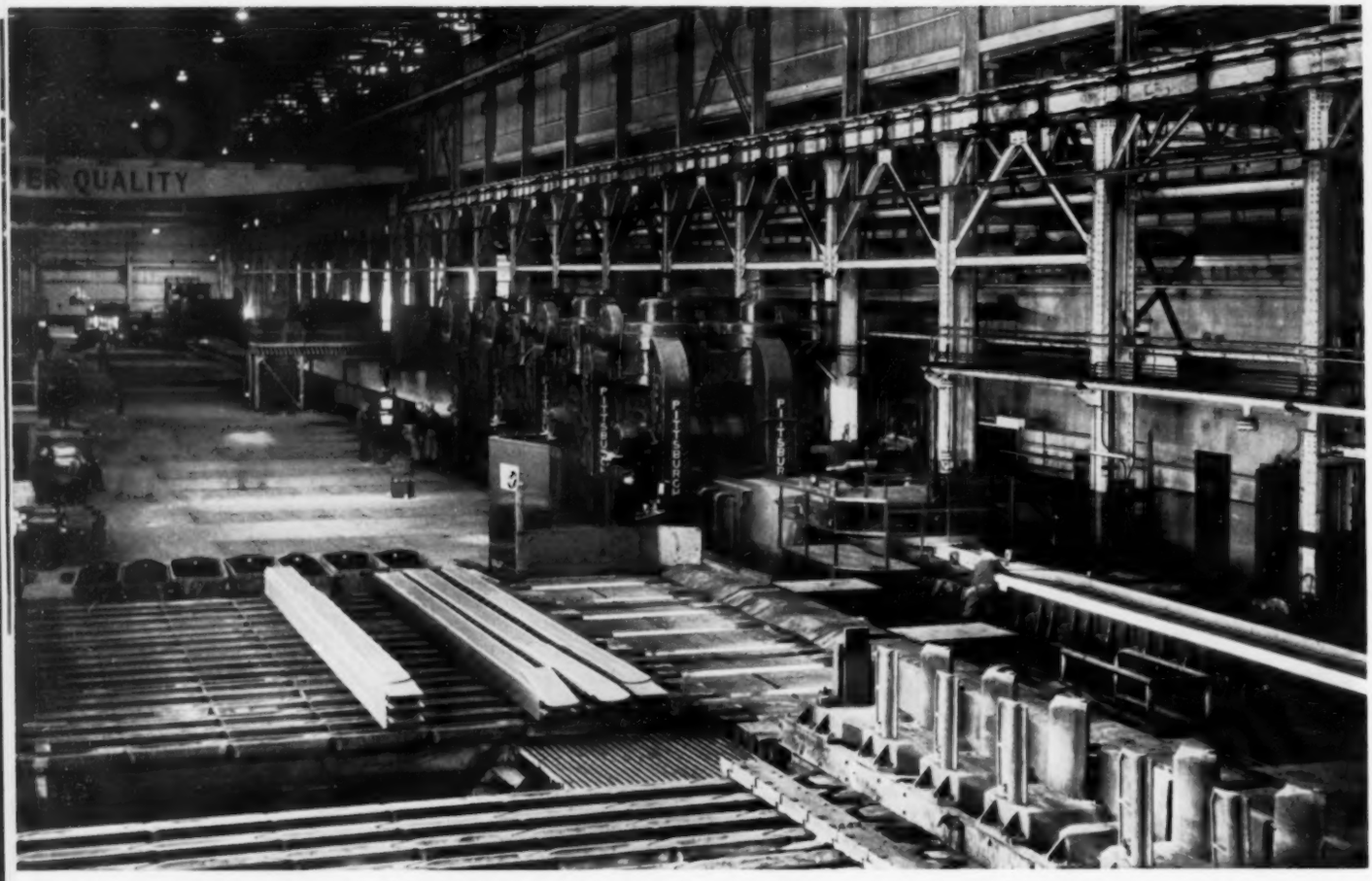
Roll adjustments on the edger are made by a 35-hp, 230-volt, d-c mill type motor. The screwdown on the roughing stand is driven by two similar 35-hp motors. Each finishing stand has two 50-hp motors operating the mill screws. Where two motors are used, a magnet clutch permits operation individually or in unison.

Roll neck bearings are bronze on the edger rolls, composition on reversing rougher rolls. In the finishing stands, work rolls run in roller bearings, backup rolls in oil-film bearings.

From the finishing train, strip passes over a runout table about 300 ft long to two rotating mandrel up-

TABLE VII
Strip Mill Data

Stand	Work rolls		Back-up rolls		Distance from preceding stand, ft-in.	Motor Data				Gear ratio	Roll rpm	Roll face speed, fpm
	Diameter, in.	Body length, in.	Diameter, in.	Body length, in.		Hp	Voltage	Type	Rpm			
Hot strip mill												
Edger	36 7/16	15 3/4	..	..	...	600	230	d-c	320/640	8.0	40/80	....
Reversing rougher	36	54	..	..	7-0	(2) 2000	500	d-c	40/80	Direct	40/80	375/750
No. 0 finisher	28	56	50	54	364-6	3500	750	d-c	30/60	Direct	30/60	220/440
No. 1 finisher	22 1/2	56	50	54	19-3	3500	750	d-c	55/110	Direct	55/110	325/650
No. 2 finisher	22 1/2	56	50	54	17-6	3500	750	d-c	90/180	Direct	90/180	532/1064
No. 3 finisher	22 1/2	56	50	54	17-6	3500	750	d-c	125/250	Direct	125/250	738/1476
No. 4 finisher	22 1/2	56	50	54	17-6	3500	750	d-c	150/300	Direct	150/300	886/1772
No. 5 finisher	22 1/2	56	50	54	17-6	3000	750	d-c	150/340	Direct	150/340	886/2007
Tandem cold mill												
No. 1 stand	21	56	53	54 3/4	...	2500	750	d-c	90/270	Direct	90/270	495/1184
No. 2 stand	21	56	53	54 3/4	13-0	(2) 2000	750	d-c	135/360	Direct	135/360	688/1980
No. 3 stand	21	56	53	54 3/4	13-0	(2) 2000	750	d-c	200/500	Direct	200/500	1100/2750
Tension reel					12-0	(2) 500	375	d-c	150/600	Direct		495/2750
Temper mill												
Payoff reel						300 kw	540	d-c	250/1000	Direct		
Mill stand	31	56	..	..	...	500	600	d-c	500/870	2.344	214/380	1735/3020
Tension reel						(2) 400	600	d-c	250/1000	1.88		



Originally four stands, the hot strip finishing train has been lengthened by the installation of another stand at each end. In the foreground are cooling beds of the billet mill.

coilers, each driven by two 75-hp, 115-volt d-c motors in series. Runout table rollers on 3-ft centers are individually driven by 4-hp d-c motors. The coilers will form coils 30-in. inside diameter and up to 59-in. outside diameter. All product from the hot mill is coiled. Drive motors for the coilers and runout table rollers receive power from two motor-generator sets, each consisting of a 250-kw generator, two 100-kw generators, a 25-kw booster and a 5-kw exciter, all driven by a 1000-hp, 1200-rpm synchronous motor.

To insure good surface on the finished strip, hydraulic descaling sprays are installed on both sides of the reversing roughing stand and at the entry side of No. 1 finisher. Water is supplied to these sprays by three 1250-gpm, 1250-psi centrifugal pumps. Spray valves are pneumatically operated under solenoid control. Steam jet blowers are also provided on the entry sides of the rougher and No. 1 finisher. Scale removed from the slabs falls through the tables and is flushed into a sump, from which it is removed by grab bucket and overhead crane.

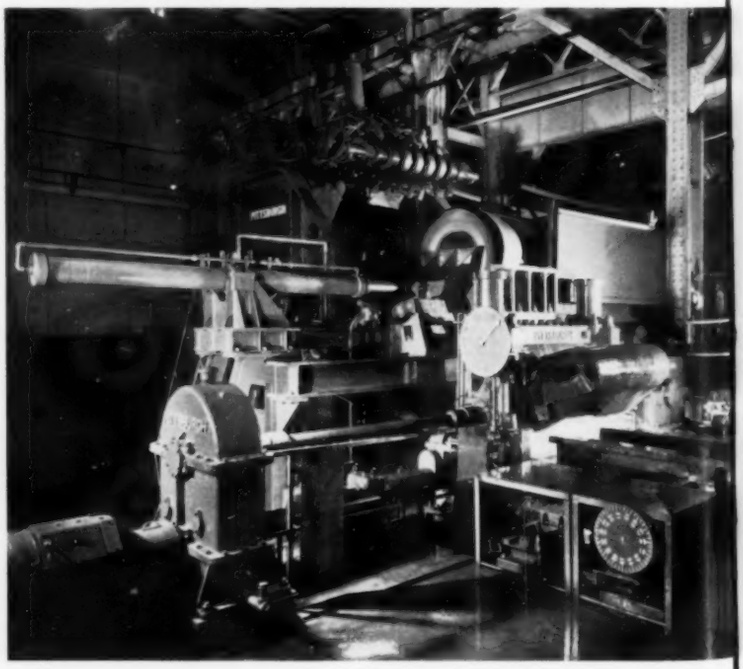
As steel progresses through the mill, its temperature is checked by radiation pyrometers at the entrance and exit of the finishing train and at the coiler.

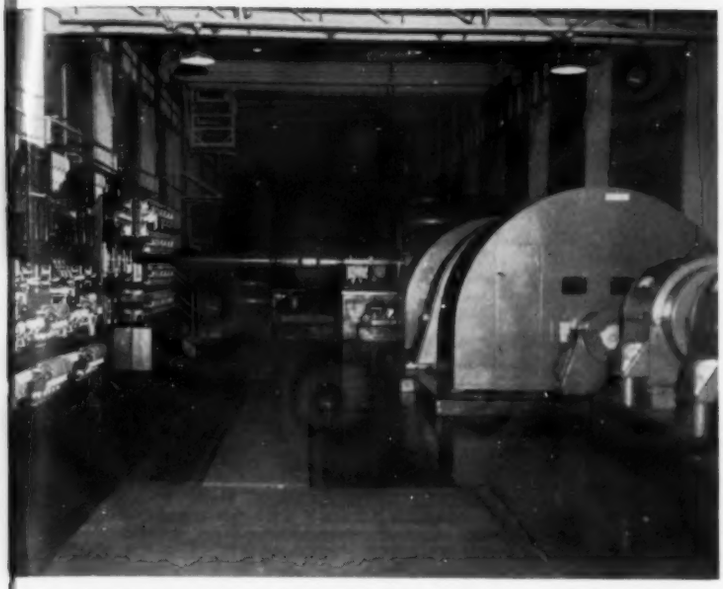
Lubrication for the hot mill is provided by four circulating oil systems, five automatic grease systems and twelve manual grease systems.

Two separate motor rooms house the strip mill drives. Both rooms are pressurized, with rotating equipment being cooled by down-draft from the circulating ventilating system. Air then passes through surface type coolers and back into the motor room. Make-up air is drawn through air filters.

The roughing stand drive operates under adjustable voltage, receiving power from a motor-generator set consisting of two 1750-kw, 500-volt, d-c generators and a 5000-hp, 11,000-volt, 514-rpm synchronous motor.

Two rotating mandrel up-coilers form even coils of 30-in. inside diameter, up to 59-in. outside diameter.





Motor room for the hot strip reversing roughing stand.

A separate 600-kw set supplies power to the edger drive. Finishing stand drives, also under adjustable voltage control, draw d-c power from three 5000-kw, 750-volt d-c, 11,000-volt a-c mercury arc rectifiers, working in parallel on a common bus.

The rolling rate of the hot mill is limited somewhat by lack of furnace capacity. At present, the mill averages 125 tons per hr but has sustained a rate of 150 tons per hr over 24 hours. Power consumption averages 43 kwhr per ton of strip.

From the coilers, coils are moved by conveyors to a storage area to await cold finishing or shipment outside of the plant.

Before cold rolling, strip is passed through a 54-in. continuous pickling line containing three 73 ft- 4 in. (10,800-gal) acid tanks, one 11 ft-6 in. (1800-gal) cold water tank, and one 29 ft-6 in. (4600-gal) hot water tank. All tanks are 71 in. wide, of steel shell construction lined with rubber and acid-resistant brick. Rubber-lined steel covers are vented to a fume exhaust system.

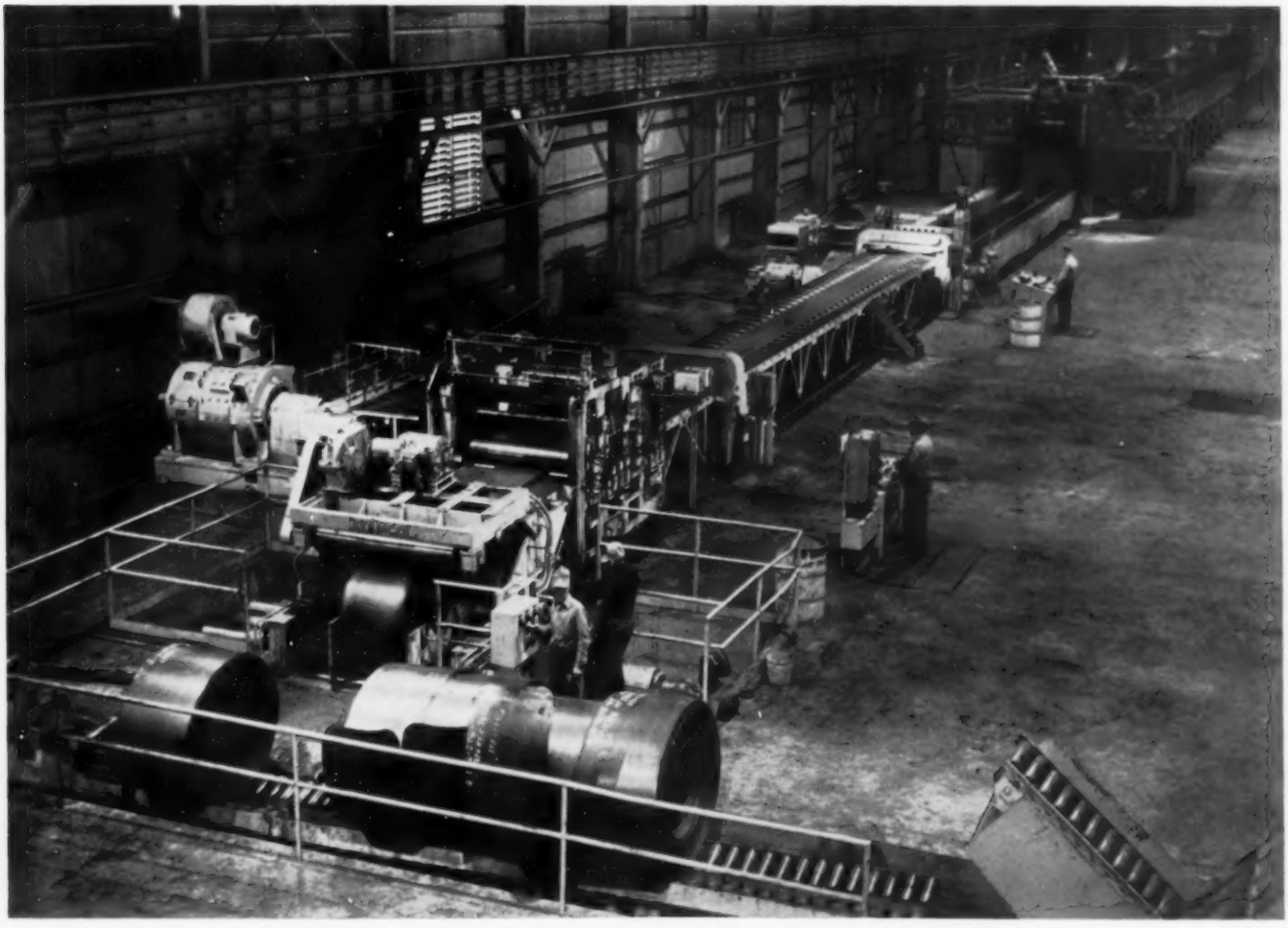
Pickling solutions for the three acid tanks, which are operated on the cascade system, contain, respectively, 10, 12 and 16 per cent of 66 degree Baume sulphuric acid. The baths are heated to 200 F by steam under automatic control. Strip speed averages about 200 fpm through the line, which is 514 ft-4 in. long overall. Production averages 50 tons per hr.

From the pickler, coils are moved by a conveyor to the cold mill building, where they are handled by ram trucks.

Cold reduction is performed on a 54-in. three-stand tandem mill with a maximum delivery speed of 2750 fpm. Details of this mill are given in Table VII.

Roller bearings are used on the work roll necks in this mill, with oil-flooded bearings on back-up roll necks. Roll adjustments are made by mill screws actuated by two 50-hp mill type motors on each stand. Two cir-

The 54-in. pickling line, 514 ft long, processes strip at about 200 fpm. Acid tanks are operated on the cascade system.



culating oil systems, and an automatic grease system provide lubrication for the tandem mill.

Power for the main drive motors, which operate under adjustable voltage control, comes from a motor-generator set consisting of five d-c generators (two of 3200-kw capacity, one of 2000-kw, one of 800-kw, and one of 300-kw) and a 13,000-hp, 11,000-volt, 360-rpm, 80-per cent power factor synchronous motor.

The reductions in gage usually effected in cold rolling range 50 to 70 per cent. Strip 18 to 49 in. wide is reduced from entering gages of 0.187 to 0.074 in. to final gages of 0.125 to 0.023 in.

The company has purchased for installation early in 1957 an electronic thickness control gage for the purpose of improving its cold rolled product quality. This gage consists of an electronic device mounted between the first and second stands to control the positioning of the screws on No. 1 stand. Another controller is located at No. 3 stand for controlling tension of the strip between No. 2 and No. 3 stands. The gage will be provided with an automatic reset device which will reposition the screws on No. 1 stand after the strip has left the stand and before the new coil has been entered. In this way gage variation between consecutive coils on the same order can be minimized by elimination of the human error in repositioning the screws for the next coil.

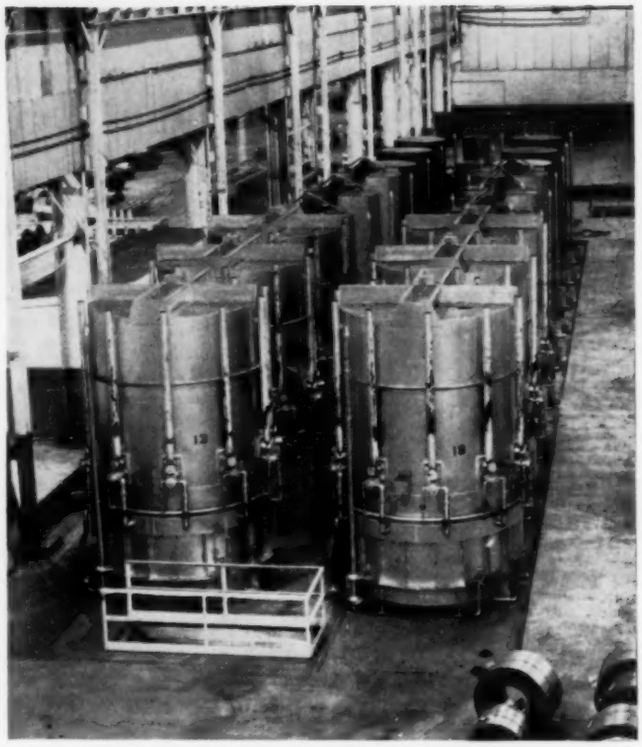
To remove the hardness caused by cold reduction, coils are annealed in 22 portable annealing covers, of which two types are used. There are 18 cylindrical, single stack covers, 106 in. in diameter x 174 in. high, with 45 bases; and four rectangular, multi-stack covers, 20 ft-6 in. long x 13 ft wide x 8 ft high, with 12 bases.

All covers are heated by natural gas burned in radiant tube heating elements. Coils are annealed at 1320 F, the cycles running 16 hr heating, 3 to 11 hr soaking and 30 hr cooling. Fuel consumption averages 1,100,000 Btu per ton. To provide an inert atmosphere during the cycle, there are four gas-conditioning machines, each of 6000 cfhr capacity.

The annealed strip is next given a skin pass (one or two per cent reduction) in a single stand, two-high temper mill, details of which are given in Table VII. This unit is equipped with roller bearings on the roll necks. Screwdowns are operated by two 15-hp mill type motors. Power is supplied to the main drive by a five-unit motor-generator set consisting of one 1500-kw, 600-volt, d-c generator, a 350-kw, 320-volt generator for the tension reel, a 200-kw, 360-volt generator for the payoff reel and a 50-kw exciter, all driven at 514 rpm by a 2500-hp synchronous motor.

Other equipment installed in the finishing department includes a 54-in. shearing line and a 48-in. slitting line.

Hot rolled coils are shipped to the company's Detroit plant or sold to other steel processors and fabricators.



All annealing is done in portable cover units heated by natural gas burned in radiant tubes. Shown here are single stack, cylindrical units.

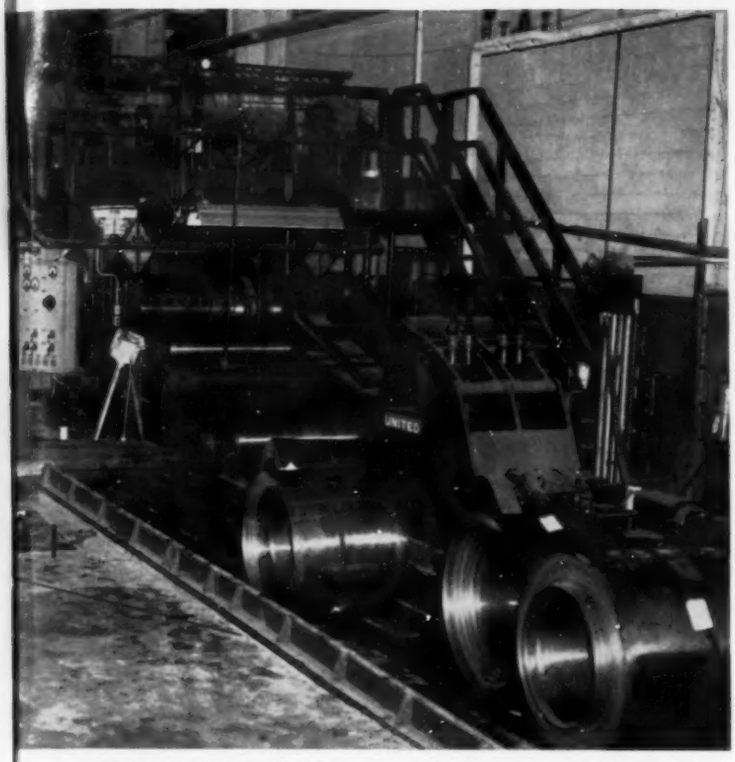
This three-stand cold mill operates at speeds up to 2750 fpm, and reduces strip thickness by 50 to 70 per cent.

UTILITIES AND SERVICES

With full operations, the Portsmouth plant uses about 15,000,000 kwhr of electric power per month. About 40 per cent of this is generated in the plant and 60 per cent purchased from the public utility system serving the area. The 30-minute demand of the plant totals about 38,000 kva, of which about 80 per cent falls against the utility company.

Purchased power comes to the plant at 34,500 volts and goes through a transformer station containing three polyphase 16,677-kva, 34,500/11,000-volt transformers. From this point, distribution is at 11,000 volts, with two lines to the blooming mill motor room, two lines to the hot strip motor room, two lines to the cold strip motor room, one line to a switching station at No. 1 powerhouse, one line to No. 3 substation in the blast furnace area, and one line to the rod mill.

From these substations, power is distributed at 11,-



This single stand skin-pass mill makes a slight reduction (1 or 2 per cent) to obtain desired temper and surface.

000, 2300 or 480 volts as required by the size of the consuming units. Direct current is distributed from conversion equipment located at strategic load centers. Motor-generators supply 230-volt, d-c power to auxiliaries in the older units, but rectifiers have been used in the recent installations.

Steam is generated at four boiler houses which are listed in Table VIII. No. 1 boilerhouse supplies steam at 600 psi pressure to No. 1 powerhouse, where a 2500-kva topping turbogenerator reduces the pressure to 150 psi, for use in the general plant system. No. 3 boilerhouse is also tied into this system and is used only for peak loads, operating very little.

No. 4 boilerhouse, the only one using blast furnace gas, produces steam principally for turboblowers and turbogenerators in No. 2 powerhouse. In addition to the blowers, this station contains a 12,500-kva, 11,000-volt generator and two 3000-kva, 2300-volt generators. All of the turbines operate on 200-psi steam. The large unit is equipped with a surface condenser. The two small units have jet condensers and run intermittently, as steam is available.

No. 6 boilerhouse serves only the coke plant area.

Water consumption of the plant averages about 106,000,000 gal per day, including recirculated quantities. Water is pumped from the Ohio River at the main pumping station, which is equipped with trash racks and stationary double screens, and contains four 20,000,000-gal per day motor-driven pumps. All of this water goes to a low-head stand-pipe, which is essentially a screening device to remove foreign material which might have escaped the river screens. From this point, all water flows to No. 4 boilerhouse and as much as 90 per cent is passed through the condensers on the turbines, on blowers and generators. Condenser water is discharged into a flume in No. 2 powerhouse and is then picked up by two pump houses and reused for plant service water. One of these pump houses contains two 15,000,000-gal per day pumps and one 20,000,000-gal per day pump. The other house has four 10,000,000-gal per day pumps.

Some water for special purposes is obtained from seven deep wells, each producing about 200 gpm. Water for boiler feed is treated with lime and soda ash in a cold continuous process.

Compressed air is supplied from four convenient centers:

Coke plant—Three 700-cfm compressors, steam driven.

Blast furnaces—One 800-cfm compressor, motor driven; two 300-cfm compressors, motor driven.

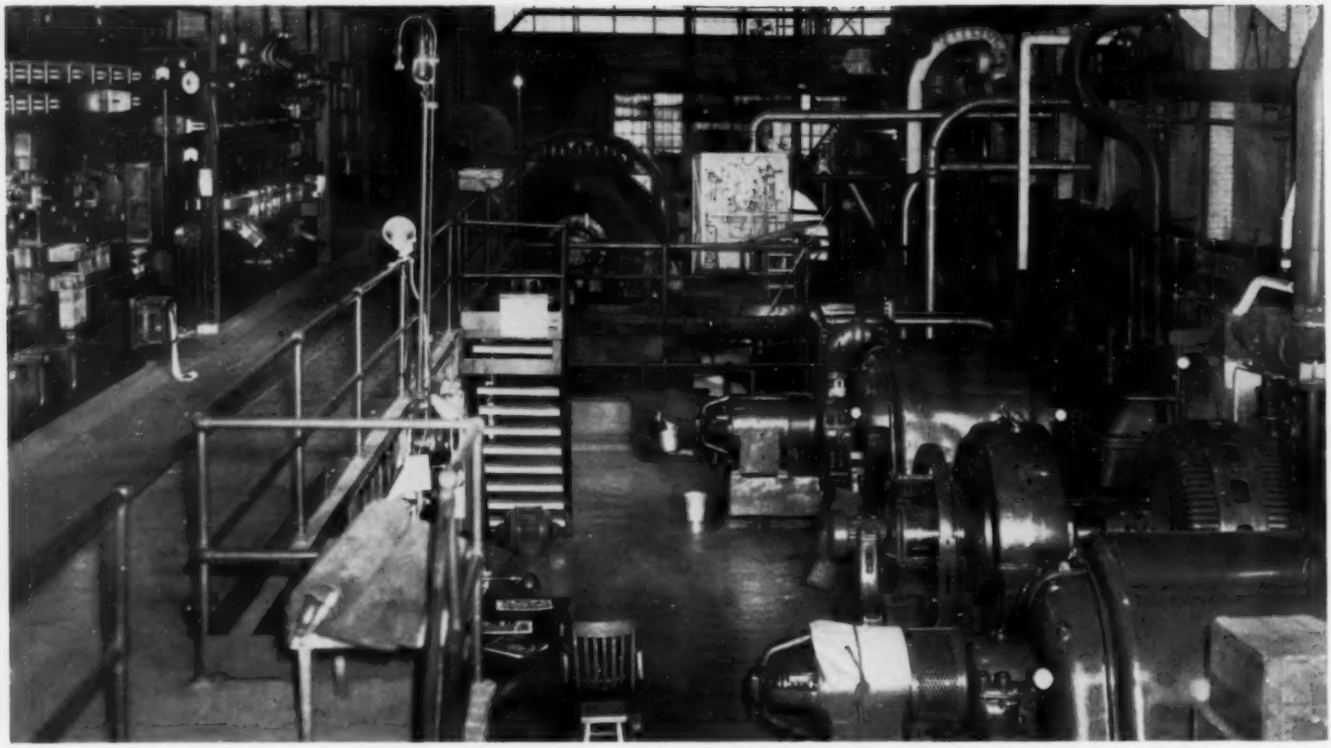
Steel plant—One 2000-cfm compressor, motor driven; one 1550 cfm compressor, motor driven; one 1800-cfm compressor, steam driven; one 1130-cfm compressor, steam driven.

Daily usage of compressed air averages about 4,400,000 cu ft.

A 40-in. main conducts clean blast furnace gas to a 2,000,000-cu ft wet seal gas holder, located approximately half way between the blast furnaces and the soaking pits, or to a 21,000-cfm booster. This booster discharges through a 36-in. line to the soaking pit area. Near the pit building, a mixing station is installed where blast furnace gas and coke oven gas are mixed,

TABLE VIII

Location	No. 1 boilerhouse		No. 3 boilerhouse	No. 4 boilerhouse	No. 6 boilerhouse
	Steel plant		Steel plant	Blast furnace	Coke plant
No. of boilers	1	1	7	8	6
Type of boilers	Bent tube generator	Bent tube generator	Bent tube	Bent tube	Bent tube
Capacity, boiler hp	1320	1450	(500)	(823)	(492)
Steam pressure, psi	600	600	150	200	150
Steam temperature, F	600	600	358	381	358
Boiler heating surface, sq ft	10,950	11,480	4020	8250	4922
Water wall surface, sq ft	2300	1820	..	..	..
Air heater surface, sq ft	8500	12,000	..	..	..
Combustion volume, cu ft	5250	5900	500	1680	550
Kind of fuel	Pulverized coal, coke oven gas, fuel oil		Coal	Blast furnace gas, coal, fuel oil	Coke breeze, coal, coke oven gas
Steam generated per year, lb	1,000,000,000		1,000,000	2,225,000,000	640,000,000
Steam used for	Power generation, general plant uses		Peak load operation. Tied into No. 1 house	Blowers, power, etc.	Heat, process, etc.



No. 2 power house contains turboblowers for the blast furnace as well as three turbogenerators.

under automatic controls, to form a fuel of any desired heating value (usually about 160 Btu per cu ft). This same station includes equipment to volumetrically mix natural gas and air to form a coke gas equivalent when it is needed. This equivalent is piped into the coke oven gas distribution system supplying the slab heating furnaces, rod mill furnace, etc.

Natural gas comes to the plant at 50 psi pressure. It is furnished to the open hearth at 20 psi pressure and at lower pressures for other plant uses.

In an average month, the plant consumes about 235,000,000 cu ft of coke oven gas, 190,000,000 cu ft of natural gas, 2,173,000 gal of fuel oil, 5330 tons of steam coal, 3230 tons of coke breeze, 380,000,000 cu ft of blast furnace gas in the soaking pits and blast furnace gas under boilers equivalent to 8480 tons of coal.

Throughout the production processes, careful check is kept on composition, characteristics and quality of the products. Chemical laboratories at the coke plant, blast furnace, open hearth and wire mill supplement a main laboratory. Observers watch details of production at the open hearth, blooming mill, strip mill and rod mill. Metallographic, technical and mechanical testing procedures are carried on in a main metallurgical laboratory. Supplementary testing for conformity to specifications and quality is done at each stage of production from the basic products through hot and cold rolled sheets and strip, and through rod and wire products.

Maintenance services for the plant are taken care of by a group of shops equipped to handle the usual run of work. One central shop, 920 ft long x 151 ft wide in three-bays, contains a forge shop, welding shop, sheet metal shop, pipe shop, carpenter shop, fabricating shop and electric repair shop. A separate machine shop contains an adequate layout of equipment to handle everything but the very large jobs. A separate shop takes care of diesel maintenance and repair.

Rolls for all mills are kept in shape in a roll shop, containing two roll grinders and a roll lathe for bar mill rolls. The roll grinders consist of a 36 in. by 16-ft unit and a 50 in. x 16-ft unit. Both grinders are equipped with suitable crowning and concaving attachments for proper grinding of rolls used in the hot strip mill and the cold mills. A third grinder, 50 in. x 16 ft, will soon be installed at the hot strip mill. This machine will be used to grind all of the rolls used in the hot mill with the possible exception of roughing mill rolls, thereby eliminating the necessity for handling rolls between the mill and roll shop.

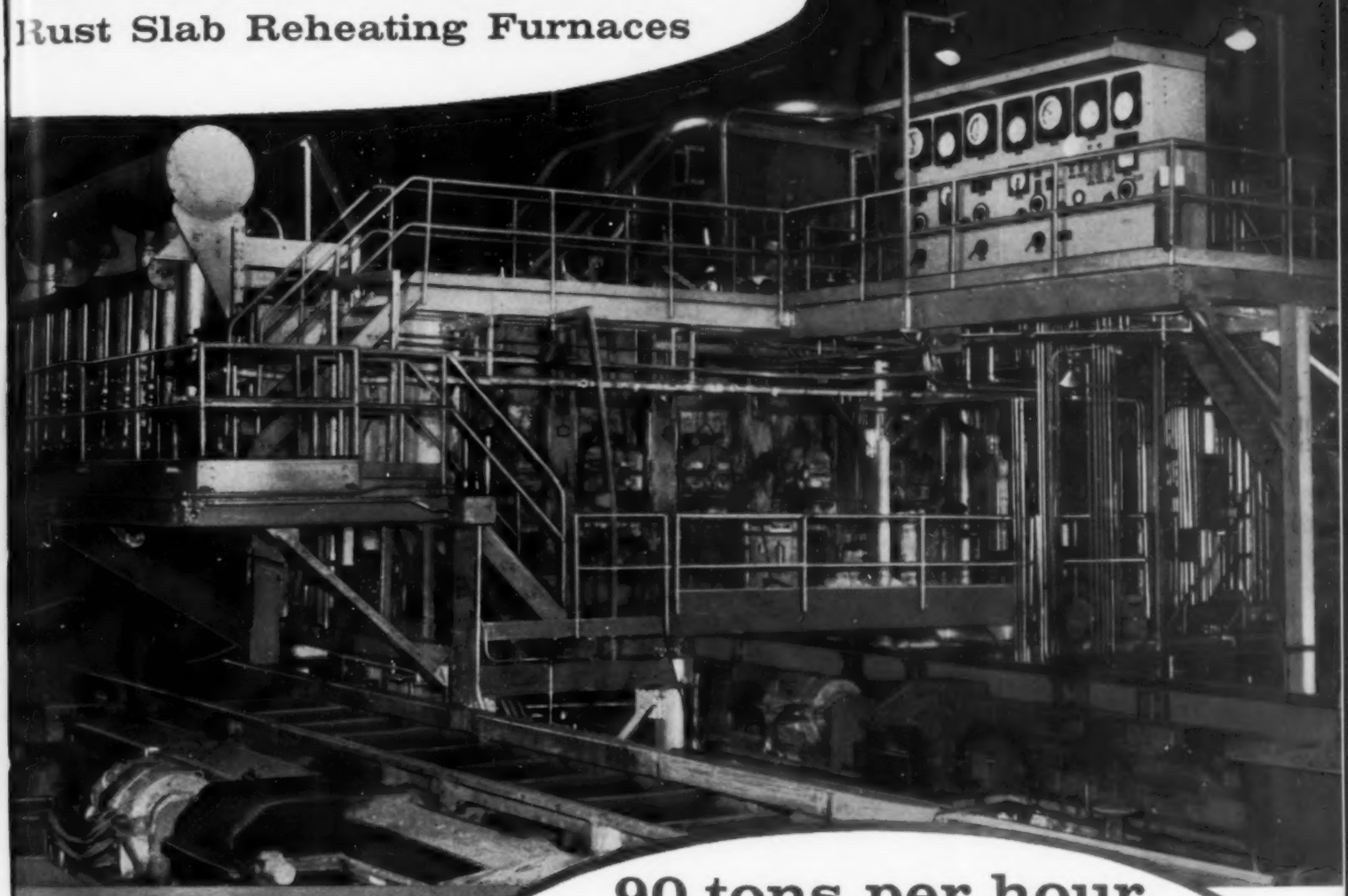
The Portsmouth plant is served by the Baltimore and Ohio and the Norfolk and Western Railroads, both of which connect with the 40 miles of standard gage track within the plant. Plant motive power consists of two 100-ton, 660-hp locomotives, seven 95-ton, 660-hp locomotives, four 70-ton, 600-hp locomotives and two 25-ton, 170-hp locomotives, all diesel-electric. They are equipped with two-way radio for efficient dispatching. The plant is also served by several first-class highways, facilitating truck shipments in all directions.

The advantages of the Ohio River site are exploited to the full capacity of the existing dock facilities which include two cranes. A considerable tonnage of traffic is handled by barge, including inbound scrap, ingot molds, fuel oil, etc., and outbound shipments of plant products.

The entire Portsmouth plant is protected by a flood wall from river stages up to 77 ft, which is 11 ft above yard level. The wall starts from a hill above the plant and continues down river about seven miles, past the city of Portsmouth. Flood gates are provided in the wall for necessary entrances. Within the plant, several flood pumps are installed to pump out water when the river is high.

Detroit Steel Corporation's modern plant at Portsmouth, Ohio equipped with

Rust Slab Reheating Furnaces



90 tons per hour

. . . the slab heating capacity of this triple-fired, end-charged, end-discharged, Continuous Reheating Furnace. Metallic Recuperator aids fuel economy.

THE WHOLE JOB IS ONE JOB WITH A "RUST PACKAGE CONTRACT"

One contract covers everything, from original idea to start-up. One responsibility for design, manufacture, erection and initial operation. One overhead and profit (with substantial savings to you) on all phases of the work, including wiring and piping.

Two of these Rust Furnaces, at Detroit Steel Corporation's Portsmouth Division, heat slabs to rolling temperature at a total rate of about 180 tons of cold steel per hour. Furnace temperature ranges from 1650°F. at the entry end to about 2400°F. at the discharge end.

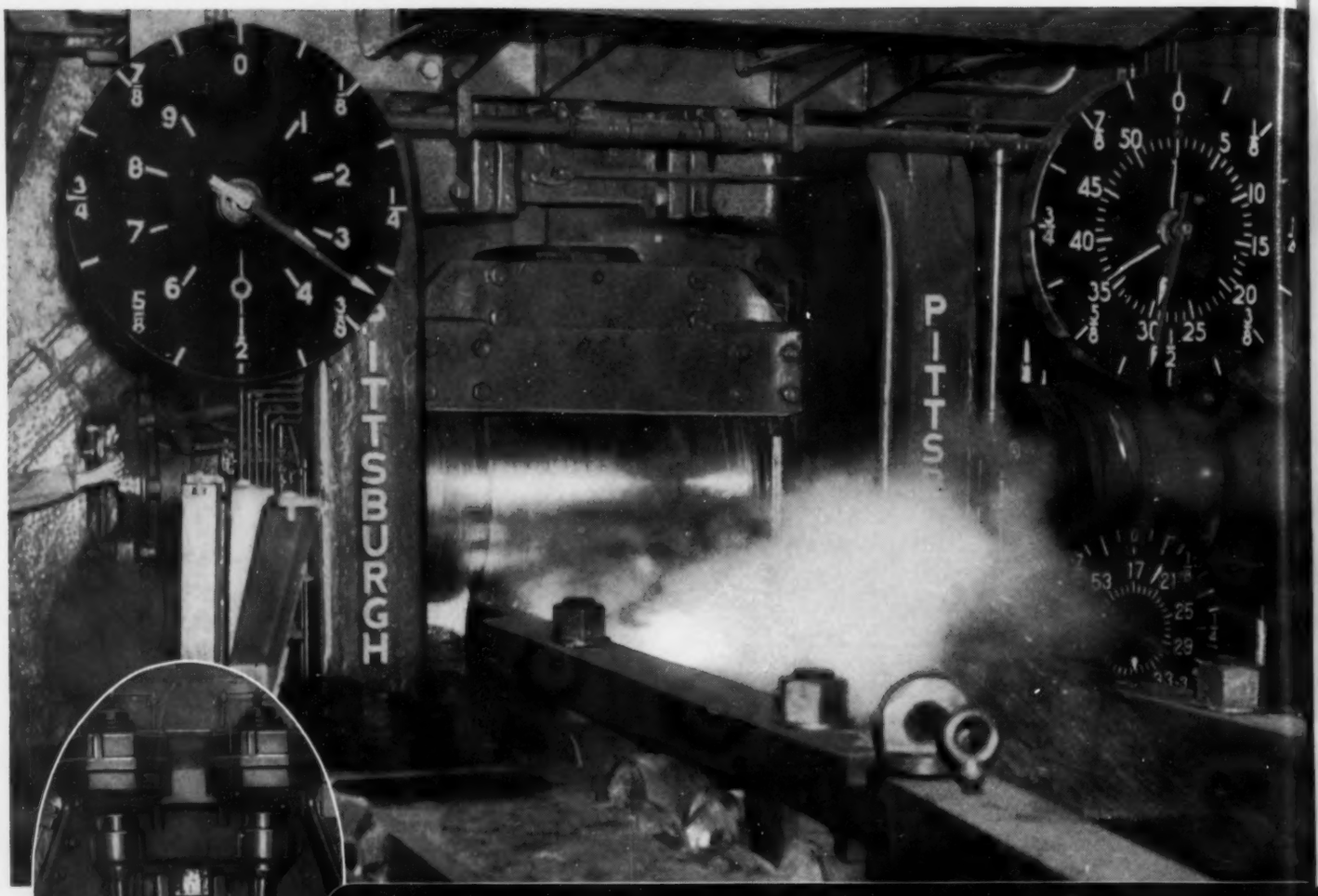
Temperature and combustion control is completely automatic, with easy operation from a central panel board. Flexibility is achieved by simply changing the fuel firing rate in the heating zone. Metallic Recuperators preheat the air for combustion, resulting in high tonnage output with minimum fuel consumption.

Rust also builds all other types of metallurgical furnaces. Consult us about your requirements. Ask for catalog.

Rust Furnace Company

Pioneers in Furnace Design

Rust Building • Pittsburgh 22, Pa.



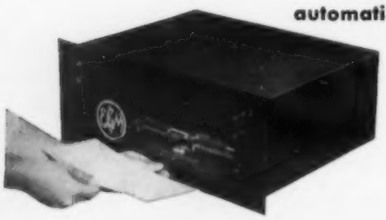
EC&M *in Action* . . .

Slab entering mill between edger rolls.
Top photo shows rear view of mill

SCHEDULING NOW AVAILABLE

By Punched Cards or Slider Panels

at left • **Punched Card Reader automatically signals roll setting for each pass**



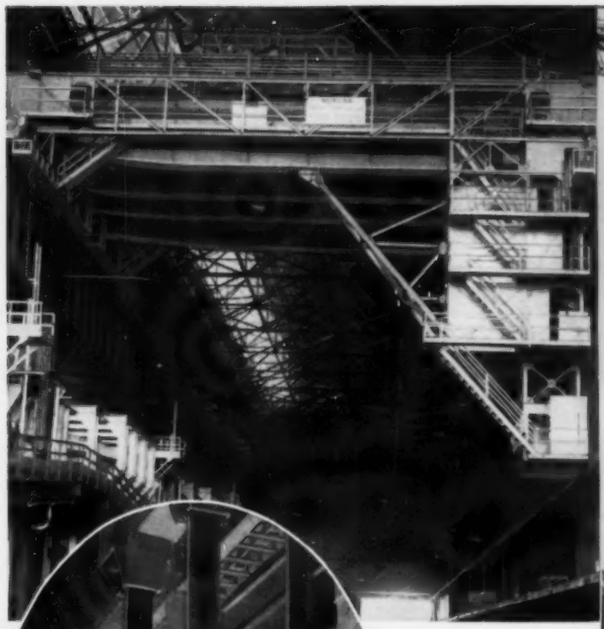
at right • **Slider Panel provides roll settings for 2 complete schedules. Pistol-grip switch provides immediate transfer from one to the other**

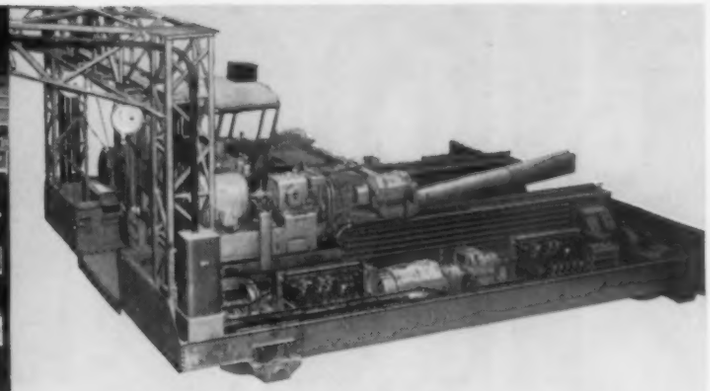
ON THE JOB SINCE 1952

WORK ROLLS, VERTICAL ROLLS and **EDGER-ROLL GUIDES** on the above Reversing Roughing Mill are positioned automatically on each pass, by pushbutton, under **EC&M AUTOMATIC-POSITIONING** Screwdown Control. One roller controls this mill's operations in which-roll settings are pre-set on direct-reading contact panels. Alternate new method is by **PUNCHED CARDS.** Both of these EC&M systems provide maximum flexibility of screwdown operation.

For the complete story, write for Bulletin 6550

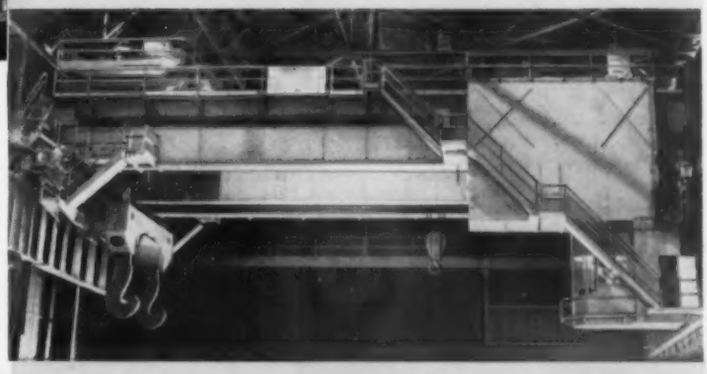
THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO





above • EC&M Disconnect Switch, low headroom Controllers, and WB Brake provide efficient control of this Charger.

below • Hot Metal Charging Crane is 100%-SAFELY operated under EC&M Control.

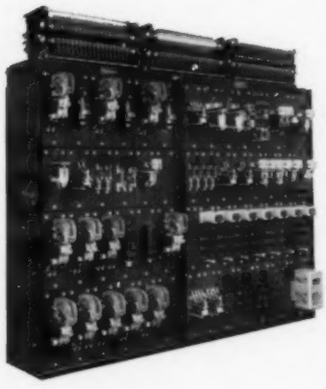


above • 350-Ton Ladle Crane equipped throughout with EC&M Control, Brakes and Limit Stops.

at left • "Jumping" quickly from mold to mold is easy with EC&M **TIME-CURRENT** Control.

. . . AT DETROIT STEEL

Modern Screwdown Control & Relay Panel



Compact, *factory-assembled* control is completely wired. At left is **TIME-CURRENT** Controller for controlling movements of screwdown motors. Right section of panel contains Relays and Magnetic Amplifiers. Tap Switches on front provide convenient adjustment for best balance-anticipator operation — thus providing quick, accurate stopping of rolls.

Mill Crane, under EC&M Control, loads outgoing shipments into railroad cars with maximum safety and dependability.

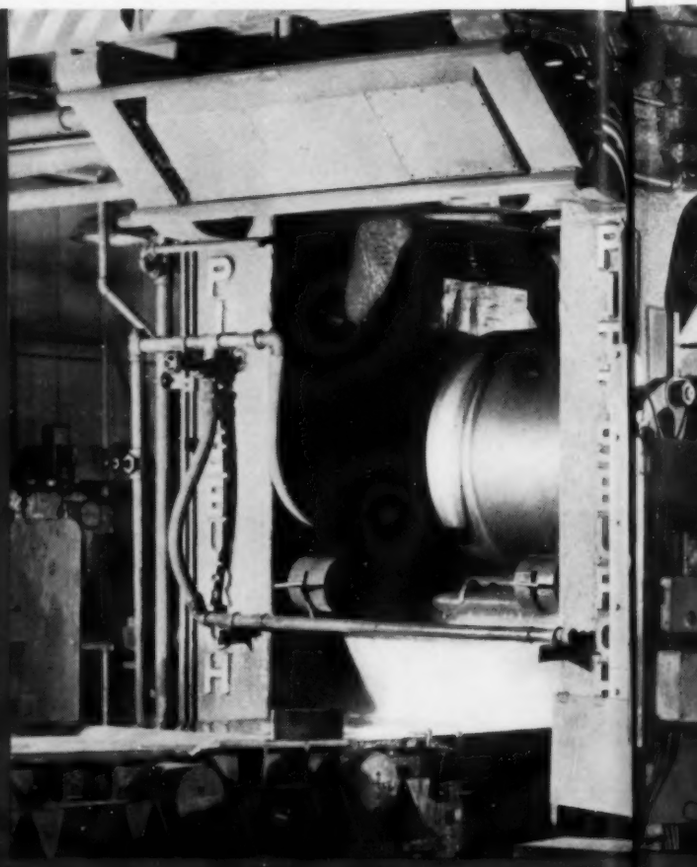
8456

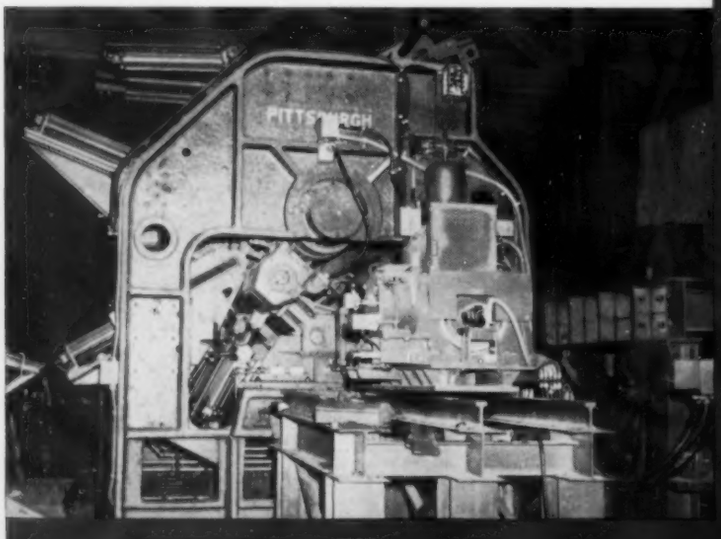
FIRST COMPLETE with DIRECT

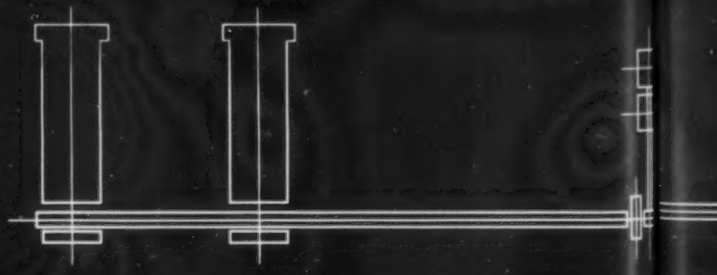
Portsmouth Installation Unique

For the first time anywhere a hot strip mill with direct drive to all mill stands has been built at the Portsmouth plant of Detroit Steel Corporation. This design eliminates the conventional large gear drive which is expensive to install, costly to maintain, less efficient in operation, and requires more space.

Pittsburgh Engineering and Machine Corporation designed, fabricated and erected this entire mill with its many outstanding features. The improved characteristics of this mill are typical of the advanced engineering incorporated in many other Pittsburgh jobs throughout the country.
We invite your inquiries for all types of rolling mills and auxiliary equipment.





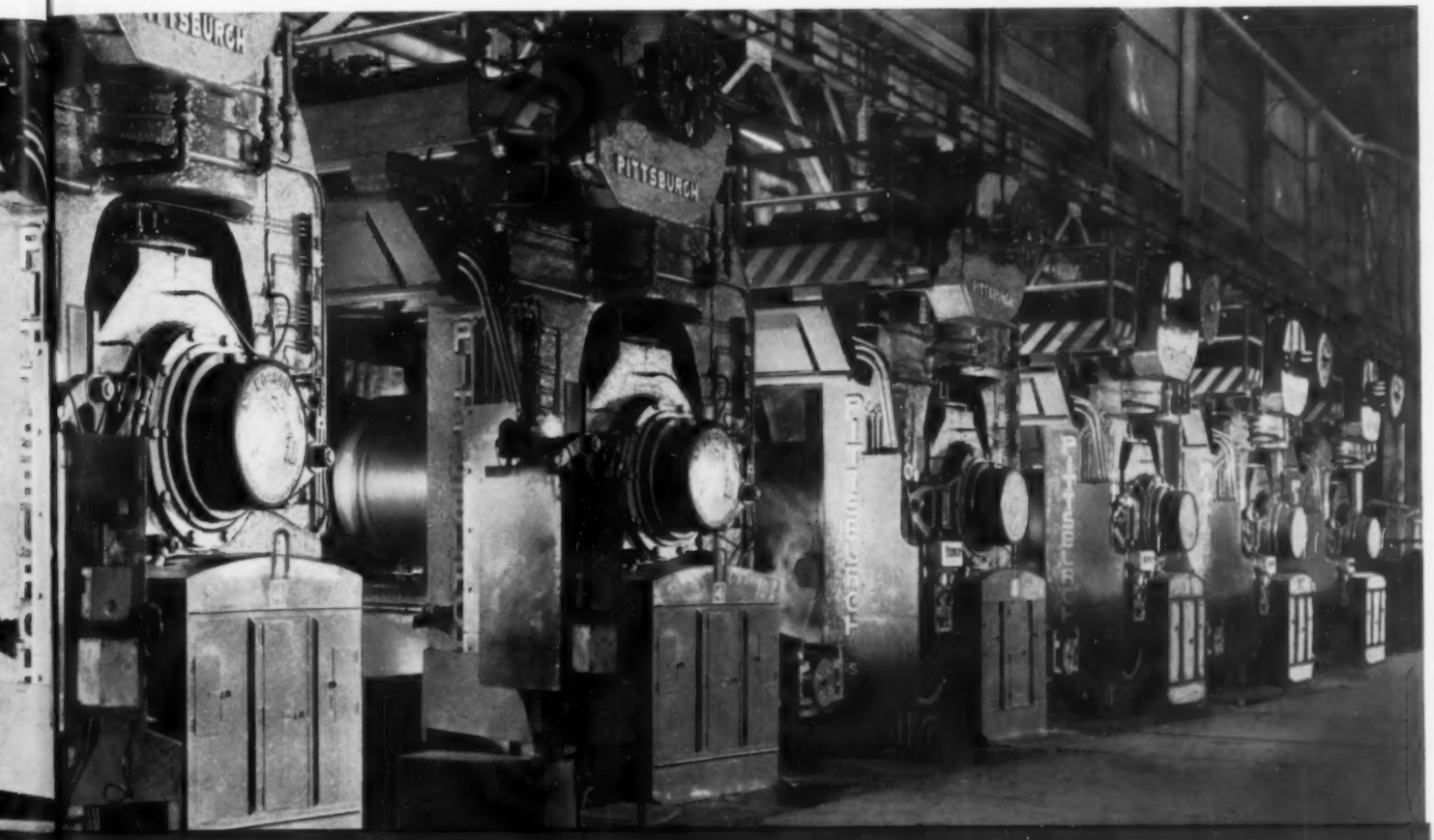


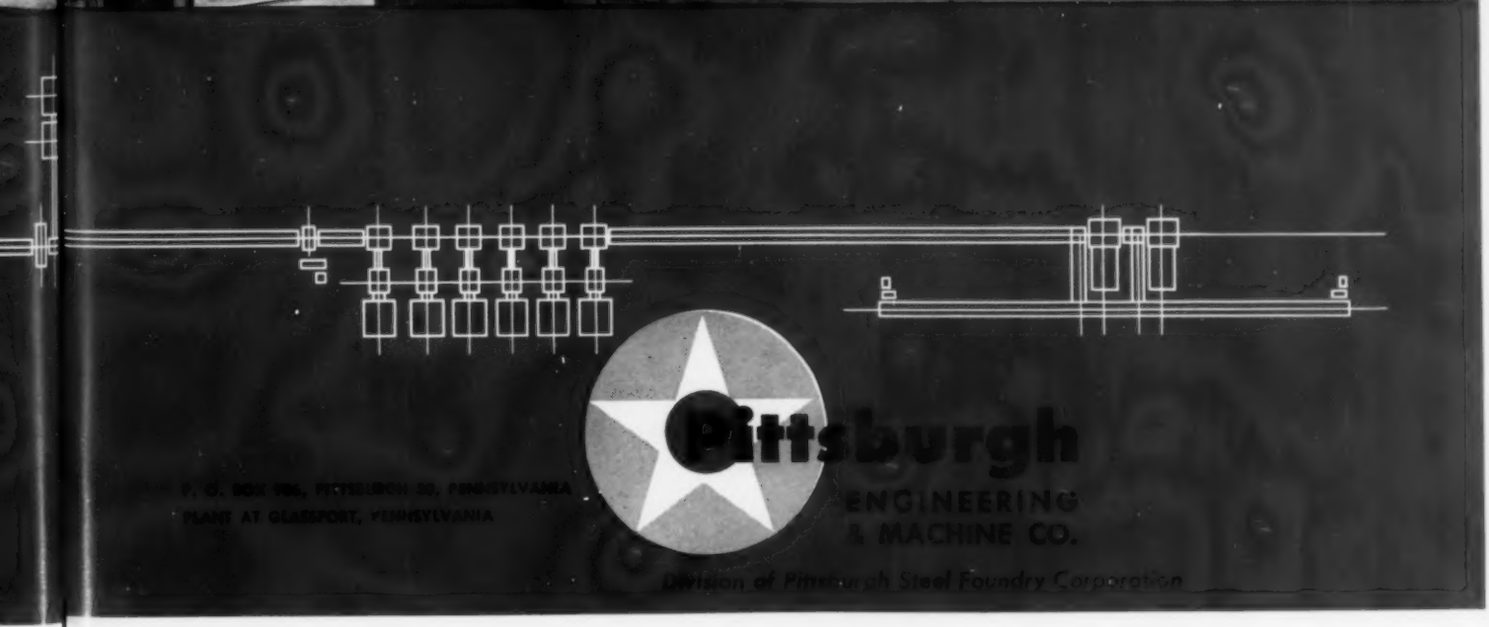
Mandrel Type Up-coilers

These Up-coilers have been especially designed to consistently produce coils wrapped firm and evenly. Their many modern features keep maintenance at a minimum of time and expense.

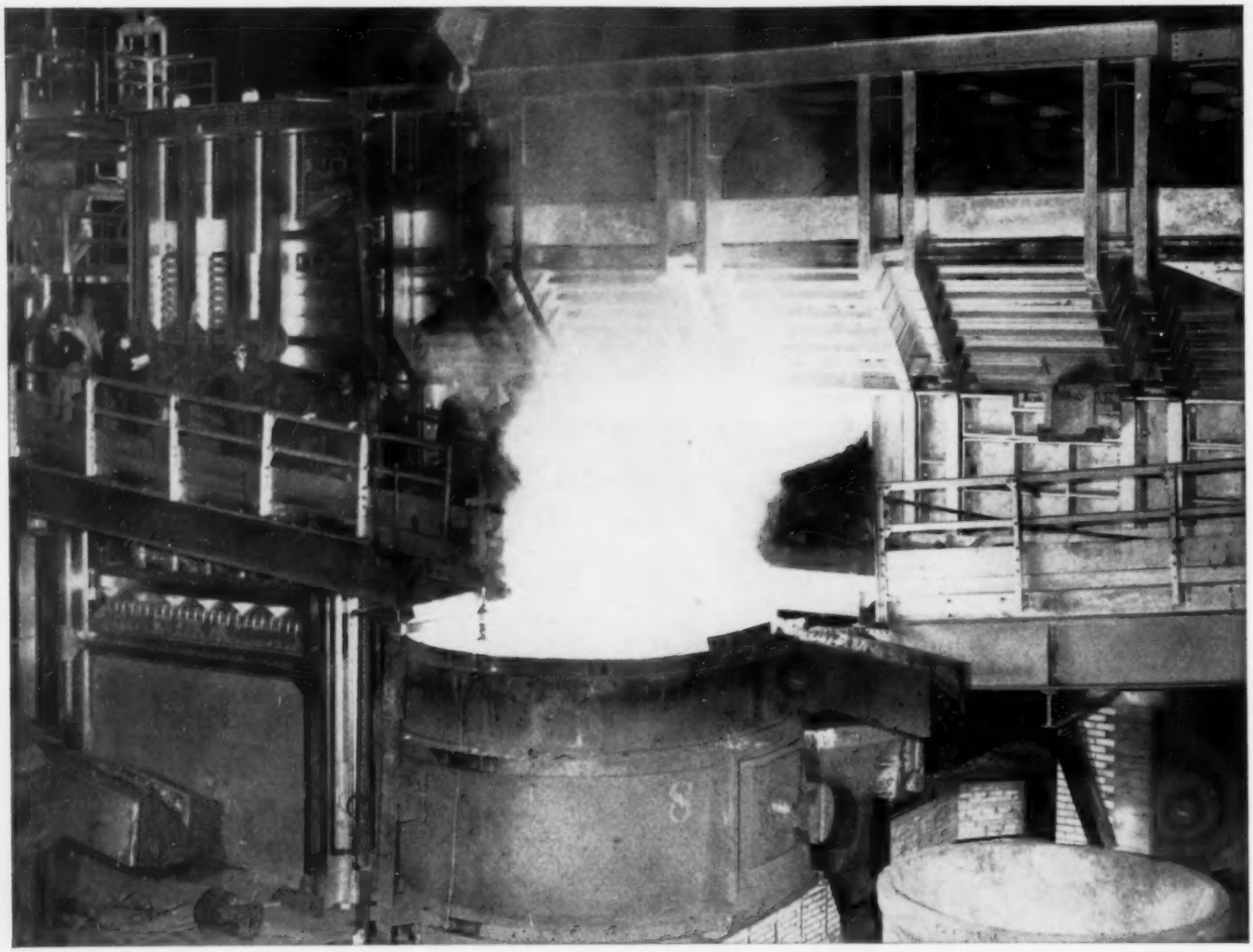
HOT STRIP MILL

DRIVE to ALL SIX STANDS





Pittsburgh
ENGINEERING
& MACHINE CO.
Division of Pittsburgh Steel Foundry Corporation



Another LOFTUS-Designed Open Hearth Furnace for Portsmouth Division, Detroit Steel Corp.

Detroit Steel Corporation recently tapped the first heat from a new 275-ton open hearth furnace at its Portsmouth, Ohio operations. This is the fifth Loftus furnace installed since 1952.

The new furnace, which is larger than the original four, is also equipped with full automatic control.

Two pass checkers have been incorporated in the design—a feature that has proved unusually successful on the other Loftus furnaces at this installation. The checker arrangement is unique in that lancing is facilitated for the full depth of the settings in both passes. This was accomplished by extending the charging floor posts to the lower pad level throughout the building, thus providing substantial access to both sides of all regenerators.

It is predicted that the performance of this new furnace will excel even the record of the original four units, which already boast one of the lowest fuel rates in the industry.

We'd like to talk to you about your requirements—without obligation. Write us today.

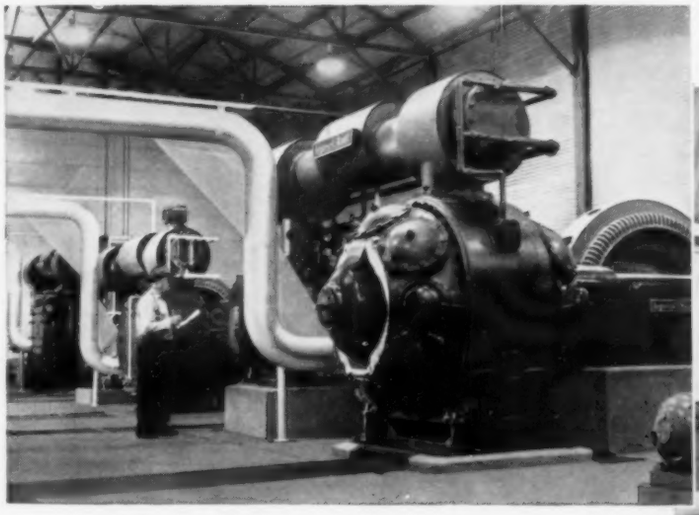
Designers and builders of industrial furnaces . . . **LOFTUS**
Engineering Corporation

1 Gateway Center, Pittsburgh, Pa.
140 S. Dearborn St., Chicago, Ill.

57.7.3

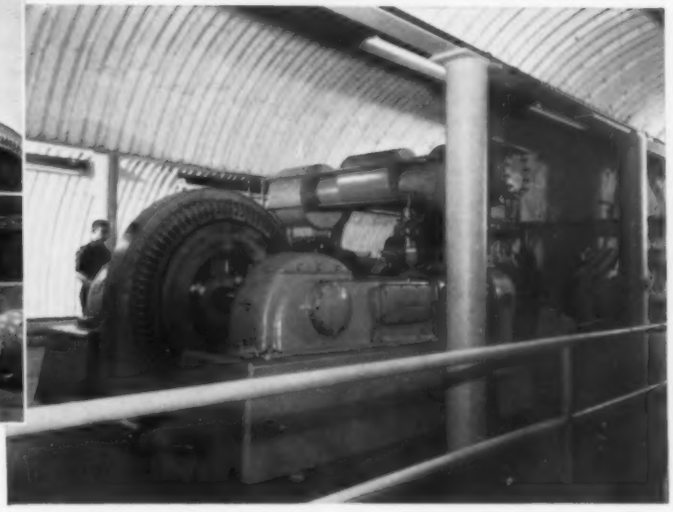
11,000 ft UP
or 4,000 ft DOWN

Ingersoll-Rand PRE Compressors keep rock drills working at top efficiency



Installed at an elevation of 11,500 feet above sea level, three 800-horsepower and two 600-horsepower Ingersoll-Rand PRE compressors, two of which are shown here, supply 100-psi air for Ingersoll-Rand rock drills at Climax Molybdenum Company's two-level development mining at Climax, Colorado. The modern compressor building is located on the surface, directly above the mine workings, which contributes to maximum efficiency for air distribution.

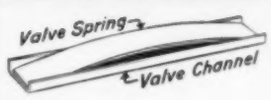
This dependable supply of air power helps keep pressure up to 90 to 100-psi at the cutting faces, thus assuring optimum results for the drilling operations which enable Climax to produce approximately 30,000 tons of ore per day.



Way down underground on the 1200 level, this 400-horsepower Ingersoll-Rand PRE compressor and two smaller units provide 100-psi drilling air for zinc and lead mining operations in Bunker Hill's Star Mine in the Coeur d'Alene district in Idaho.

Located 1200 feet below the shaft coliar, these units feed into the same air line as another PRE unit on the *4,000 level.* With dependable I-R compressors at both ends of the system, line losses are reduced and full pressure is maintained at the drills.

Only I-R Compressors have CHANNEL VALVES



- High Efficiency
- Quiet Operation
- Remarkable Durability
- Air-Cushioned Action
- Corrosion-Resistant
- Channels are rigid
- Entirely different

Ingersoll-Rand PRE Compressors, of the horizontal, double-acting crosshead type, are heavy-duty machines built for continuous full-load service. Their extra stamina and low maintenance are big assets in mining service. The completely sealed frame keeps out dust and dirt. Running gear requires no internal adjustments.

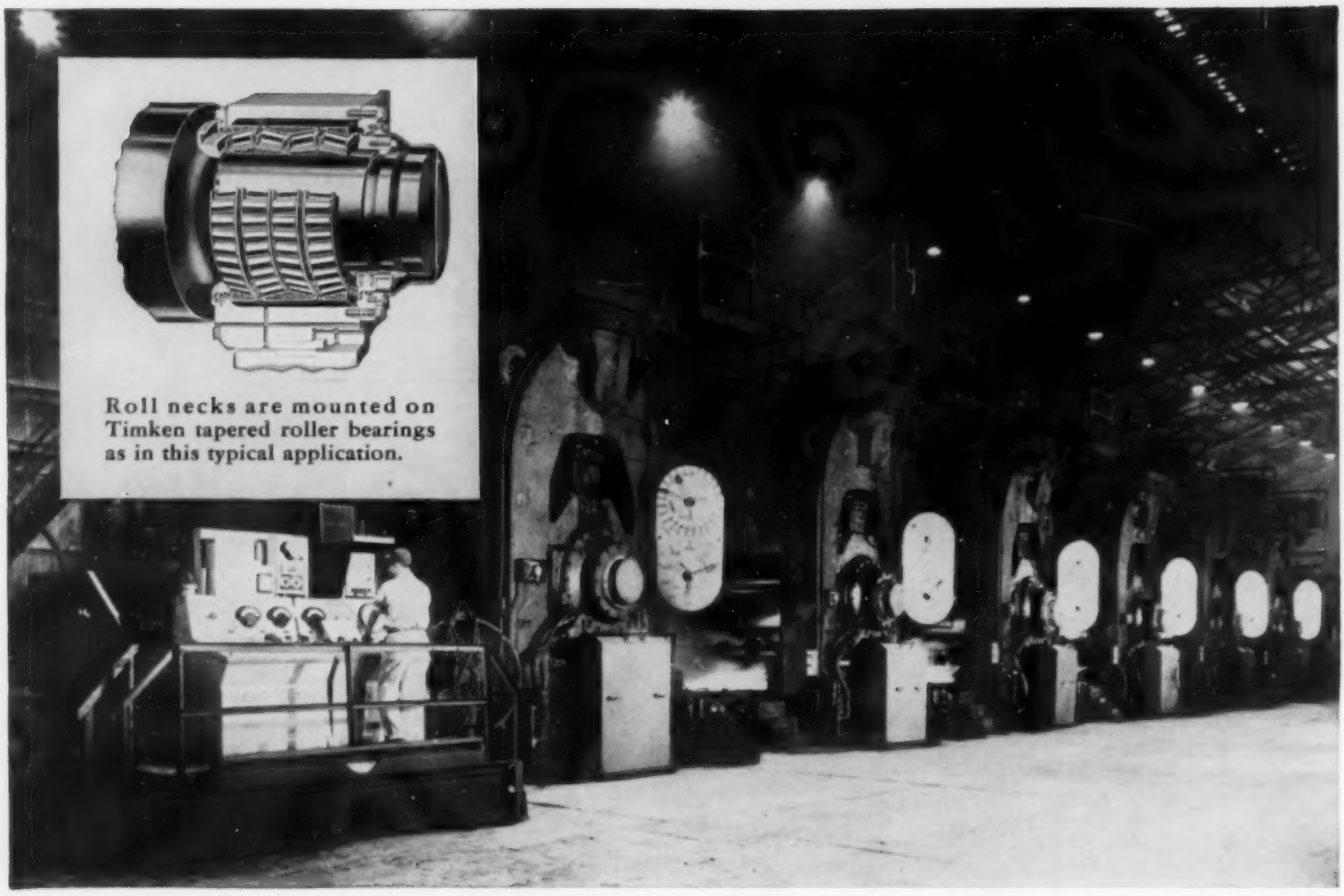
Pipeless force-feed lubrication cuts operating and maintenance costs. These and many other features make the PRE an ideal compressor for use wherever large volumes of air are to be handled and pressures must be maintained within close limits over the complete capacity range. Ask your I-R representative for complete information.

Ingersoll-Rand

1-431

11 Broadway, New York 4, N. Y.

COMPRESSORS • GAS AND DIESEL ENGINES • ROCK DRILLS • PUMPS • TURBO-BLOWERS • AIR AND ELECTRIC TOOLS



Roll necks are mounted on Timken tapered roller bearings as in this typical application.

New design TIMKEN® work roll bearings average 75% more tonnage than previous design on hot strip mill

TO take the loads of high speed production and reduce mill delays, a Midwestern steel mill installed a new design of Timken® bearings on the work rolls of its 4-high 80″ continuous hot strip mill. By the end of 1955, production figures revealed that the new design Timken bearings averaged 75% more tonnage in the fixed position—where service is most severe. This increased tonnage came from increased radial and thrust capacity in these new bearings. The net result was a substantial reduction in bearing cost. And this new design made higher performance possible with no increase in space. It's another example of how Timken Company engineering can help cut costs and reduce mill delays.

These new design Timken work roll bearings are compiling amazing records because 1) Timken advanced engineering designed these bearings for the job. 2) They were precision-manufactured for longer life. 3) Their true rolling motion, made possible by the tapered design and smooth surface finish, practically eliminates friction. Performance records compiled by mill operators everywhere prove Timken work roll bearings provide minimum cost per ton of steel rolled.

So, to minimize mill downtime with correspondingly lower operating costs, be sure you specify Timken tapered roller bearings in the mill equipment you build or operate. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN *TAPERED ROLLER BEARINGS ROLL THE LOAD*

TRADE-MARK REG. U. S. PAT. OFF.

...for Cranes and Charging Machines

at PORTSMOUTH DIVISION - DETROIT STEEL CORPORATION

Over 150 P-G Standard Resistor units are used to control this 350-ton Ladle Crane recently placed in service. These rugged nonbreakable units help keep this large crane in continuous operation at minimum cost. You, too, can obtain this same "Trouble-Free Service" if you specify P-G the ORIGINAL Steel Grid Resistor for your next application. *Write for Bulletin No.* 500.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

Mechanical PERFECTION Achieved by Eichleay

Continuous Strip-Pickle Line

Semi Continuous Hot Strip Mill-Foundation

Semi Continuous Hot Strip Mill-Mill Proper

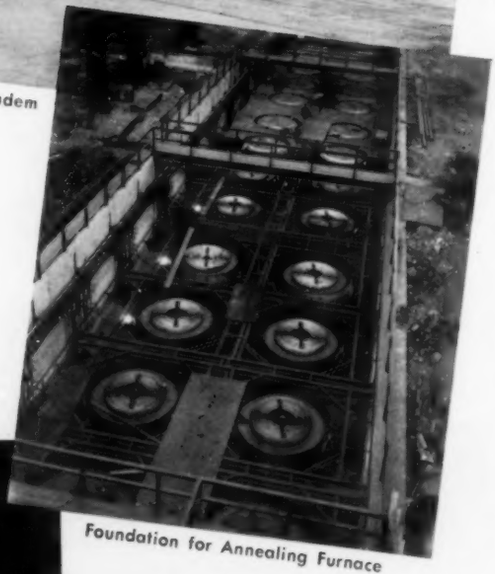
at the

Portsmouth, Ohio Works of

DETROIT STEEL CORPORATION

Three-Stand Tandem Cold Mill

The work at Portsmouth included placement of foundations and mechanical installation of Hot strip Mill, 3 Stand Tandem Cold Mill, Temper Mill, Continuous Strip Pickling Line, Annealing Furnaces and miscellaneous auxiliaries necessary for the production of finished strip products.



Foundation for Annealing Furnace

Eichleay

ESTABLISHED 1875

EC

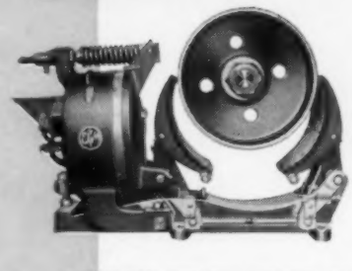
CORPORATION

33 South 19th St., Pittsburgh 3, Pa.

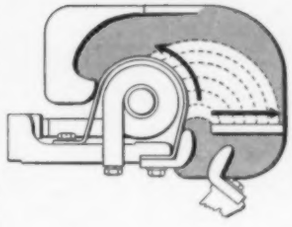
681 Market St., San Francisco 5, Calif.

It's EC&M for a Complete Line of ELECTRIC CRANE CONTROL

BRAKES · DISCONNECT SWITCHES · CONTROLLERS · LIMIT STOPS

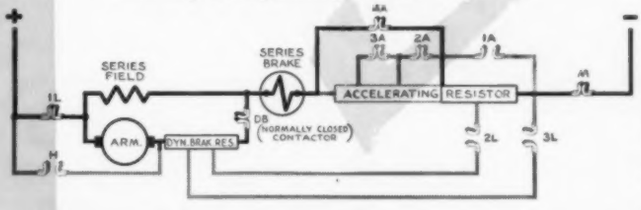


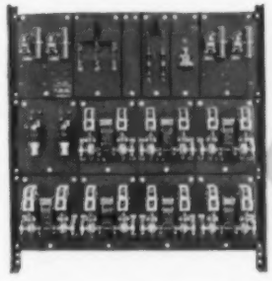
LONG-LIFE BRAKES for cranes operated by A.C. or D.C. power. High speed performance. Low upkeep.



CONTACTORS operate on the LINE-ARC principle. No destructive burning of arc shields. Cool contacts and reduced maintenance.

DYNAMIC LOWERING CIRCUITS for hoist motions. Respond quickly. Permit accurate inching for spotting loads.

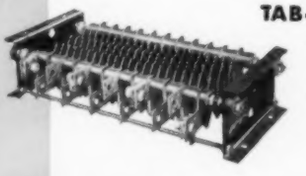




REVERSING-PLUGGING CONTROL for bridge and trolley motions. Automatically controlled acceleration. Only one simple relay for plugging.

YOUNGSTOWN SAFETY LIMIT STOPS protect against overhoisting accidents. Positive check against human errors.

CAM-TYPE MASTER SWITCHES have narrow width and short throw. Less operator fatigue.



TAB-WELD PLATE RESISTORS —spot-welding provides a continuous path, and keeps resistance value constant.

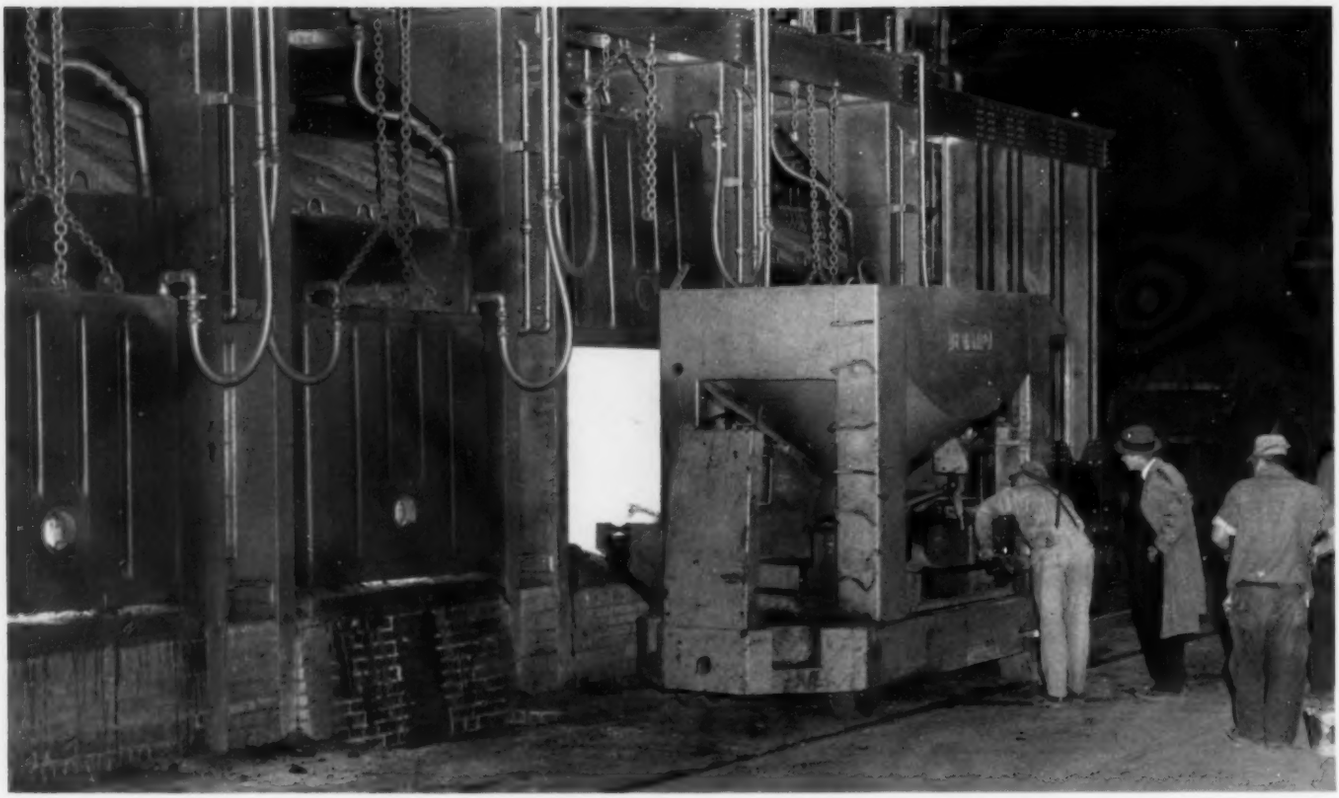
MANUAL-MAGNETIC DISCONNECT SWITCHES are very easy to operate. They are arranged to control crane lights, too.

THE ELECTRIC CONTROLLER & MFG. CO.

A DIVISION OF THE SQUARE D COMPANY

CLEVELAND 28 · OHIO

7405



Making up a modern Open Hearth Furnace with dead burned dolomite using a Blaw-Knox machine

in just seven years . . .

Detroit Steel Corporation boosts ingot capacity 125%

In the early 1920's . . . before anyone ever thought of them as "roaring" . . . a small strip steel mill opened for business in Detroit, known as the Detroit Steel Company.

To many, this was just another factory in a fast-growing community. But, to its determined management it was an event endowed with *greatness*. And, within 12 years, its capacity had increased as many times.

Recent growth most significant

In 1950 came Detroit Steel's most important advance . . . the acquisition of the historic Portsmouth Works at Portsmouth, Ohio. There, the company began a multi-million-dollar expansion program designed to double the capacity of the Portsmouth Works and to transform them into a modern integrated steel mill with balanced steel-finishing facilities.

Annual ingot capacity will soon soar to 1,500,000 tons . . . an increase of 125% in seven years . . . far outstripping the advance of the steel industry as a whole. Thus, through progressive planning and sound expansion, Detroit Steel continues to move forward while assuming its place among our great American industries.

The J. E. Baker Company is proud of its long association with Detroit Steel. It, too, has an enviable record of expansion and product improvement. Indeed, many steel "greats" today insist on Baker's Magdolite . . . the original dead burned dolomite . . . because it has been proved five ways better: in *composition, preparation, strength, economy,* and *quality.*

ANOTHER AMERICAN ORIGINAL

JEBCO PRODUCTS SINCE 1889

BAKER'S MAGDOLITE

The original dead-burned dolomite

THE J. E. BAKER COMPANY

YORK, PENNSYLVANIA • PLANTS: BILLMEYER, YORK, PENNSYLVANIA • MILLERSVILLE, OHIO

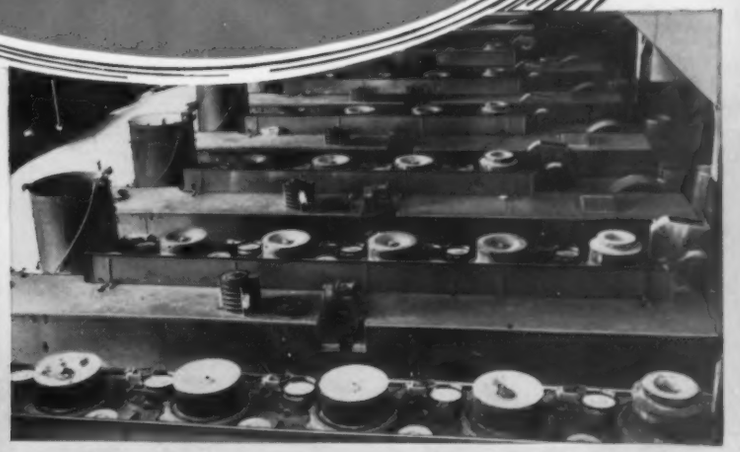
. . . for
Detroit Steel
Corporation's

PORTSMOUTH
DIVISION

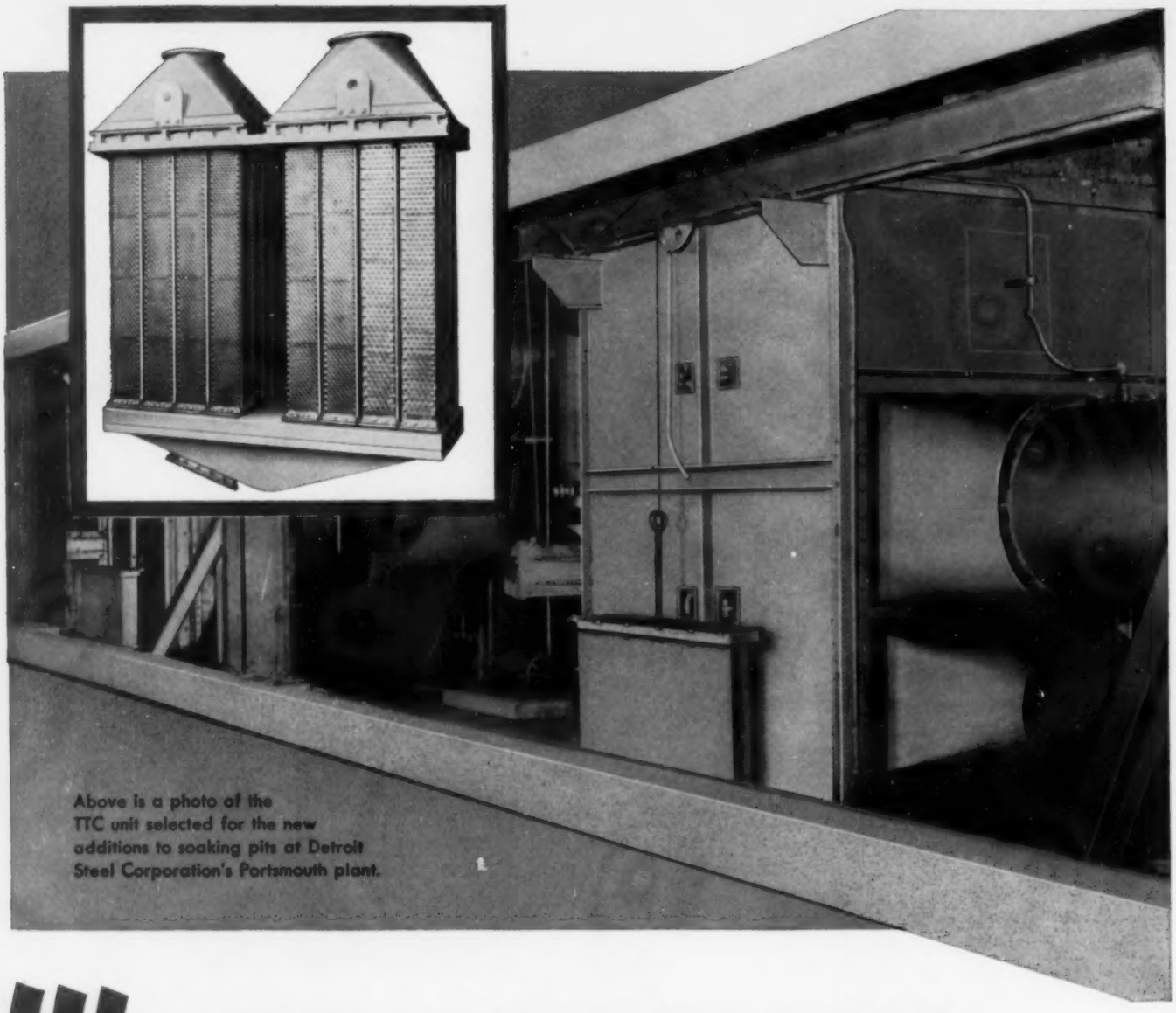
Millions of miles of
Quality Wire

with **VAUGHN®**
HRM
MOTOBLOX®

At PORTSMOUTH, Vaughn Motoblox serve with steadfast dependability in producing wire of highest quality—on exacting production schedules. The Portsmouth battery of HRM Motoblox is the original installation of this type of machine, and we are proud indeed of its impressive service record.



The VAUGHN MACHINERY CO. CUYAHOGA FALLS, OHIO, U.S.A.
COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys



Above is a photo of the TTC unit selected for the new additions to soaking pits at Detroit Steel Corporation's Portsmouth plant.

TTC Recuperators Serve Every Soaking Pit At Detroit Steel's Portsmouth Plant

For the third time, Detroit Steel Corp. has specified TTC Needle-Type Metallic Recuperators for soaking pit installations. Where fuel is a vital cost factor in heating metals for rolling, you can reduce your fuel costs by amounts up to 50% with these valuable units. TTC Recuperators preheat combustion air up to 1300°F and reduce fuel requirements on the heating equipment. Flexibility of application, modular unit installation, and long, trouble-free service are assured with TTC Recuperators. The design minimizes leakage as well as pressure and draft losses. Let TTC help you increase your fuel and furnace economies, and improve your furnace yield. Write today for further information.

Thermal Transfer Corporation

INVESTMENT BUILDING • PITTSBURGH 22, PA. • ATlantic 1-0437

Wean, Fairless and Tinplate

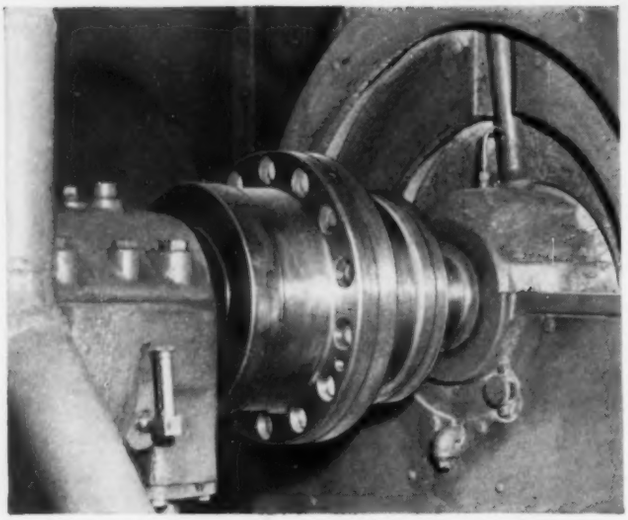
WHEN U. S. Steel conceived the idea for their Fairless Works, they wanted the fastest, most modern lines possible. But, more important, they wanted equipment that would improve product quality.

That's why, when they began thinking tinplate, they came to Wean — the world's foremost designer of electrolytic cleaning and tinplate equipment. In conjunction with U. S. Steel engineers, Wean produced a continuous tinplate line that has established records for both speed and product quality.

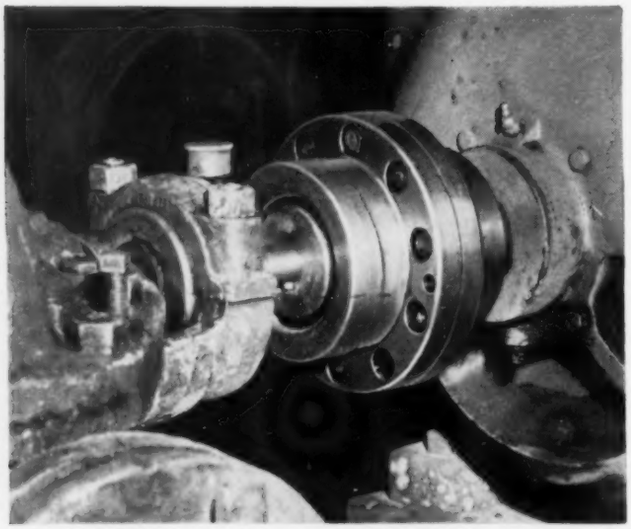
If you're thinking tinplate — remember 75 per cent of all tinplate produced by the electrolytic process is made on Wean engineered lines.

WEAN

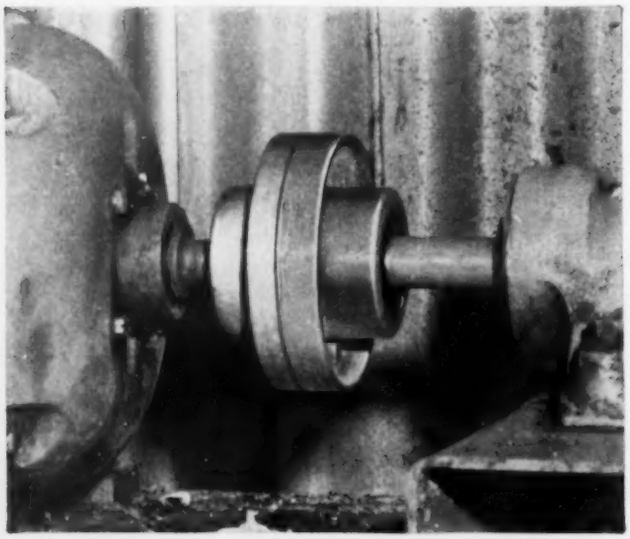
THE WEAN ENGINEERING COMPANY WARREN, OHIO



Fast's #4½ Coupling on a 1200 GPM Wilson-Snyder descaling pump. A 1500 hp., 1770 rpm motor drives the unit which operates at a head of 1250'.



Fast's #2 Coupling on a Worthington Type 4-L-1 1000 GPM pump operating at a head of 175'. Pump speed is 3570 rpm. Motor is 60 hp.



Fast's #1 Coupling on a 2500 CFM ventilating fan. Fan motor is 1½ hp. Rpm is 1800.

Detroit Steel Keeps 100 Fast's Couplings at Work with Only Minimum Maintenance

Fast's Couplings have reduced costly downtime and maintenance at Detroit Steel Corporation's Portsmouth, Ohio hot strip mill. Over 100 in number, they range in size from #1 to #20. Many of these couplings have operated with practically no maintenance for six years. Detroit Steel chose Fast's Couplings because of their *sound basic design.*

Here's why Fast's design pays off in low-cost maintenance and trouble-free performance: mechanical flexibility compensates for misalignment. Couplings last longer because there's no metal-to-metal wear. Positive lubrication forms a film on load-carrying surfaces. Metal-to-metal seal keeps out dirt, grit and moisture.

For more details, write to KOPPERS COMPANY, INC., Fast's Coupling Dept., 3004 Scott St., Baltimore 3, Md.

THE ORIGINAL

KOPPERS

FAST'S Couplings

Engineered Products Sold with *Service*

AAF air filters *keep it that way* for Detroit Steel's Portsmouth Division

Did you ever see a cleaner, brighter motor room? It typifies the investment-protection planning that went into Detroit Steel's Portsmouth Division at Portsmouth, Ohio. From AAF's complete air filter line, the company was able to select the *right* filters to guarantee a continuing supply of clean air for long, uninterrupted motor room service.

Three distinctly different filter types are in operation—dry type, viscous impingement and electrostatic. They are supplying nearly 300,000 cfm of super-clean air to motor rooms serving blooming mill and cold mill operations.

The filters—Roll-O-Matic, Multi-Duty and Electro-Matic—are all automatic, self-cleaning units. For complete information on any or all, call your local American Air Filter representative or write us direct.

AAF Filters and Precipitators

AAF Dust Control Equipment

American Air Filter
COMPANY, INC.
302 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

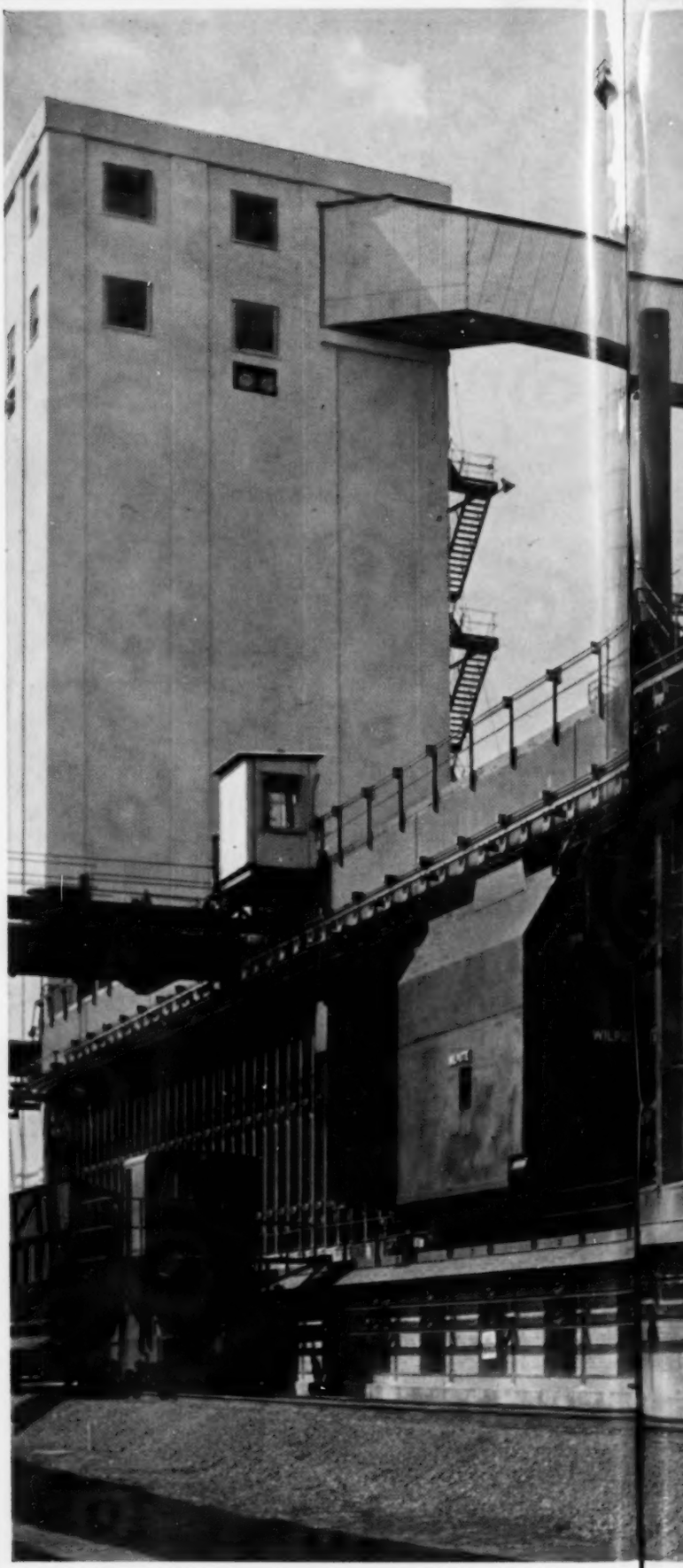
BETTER AIR IS OUR BUSINESS

Herman Nelson Unit Heaters

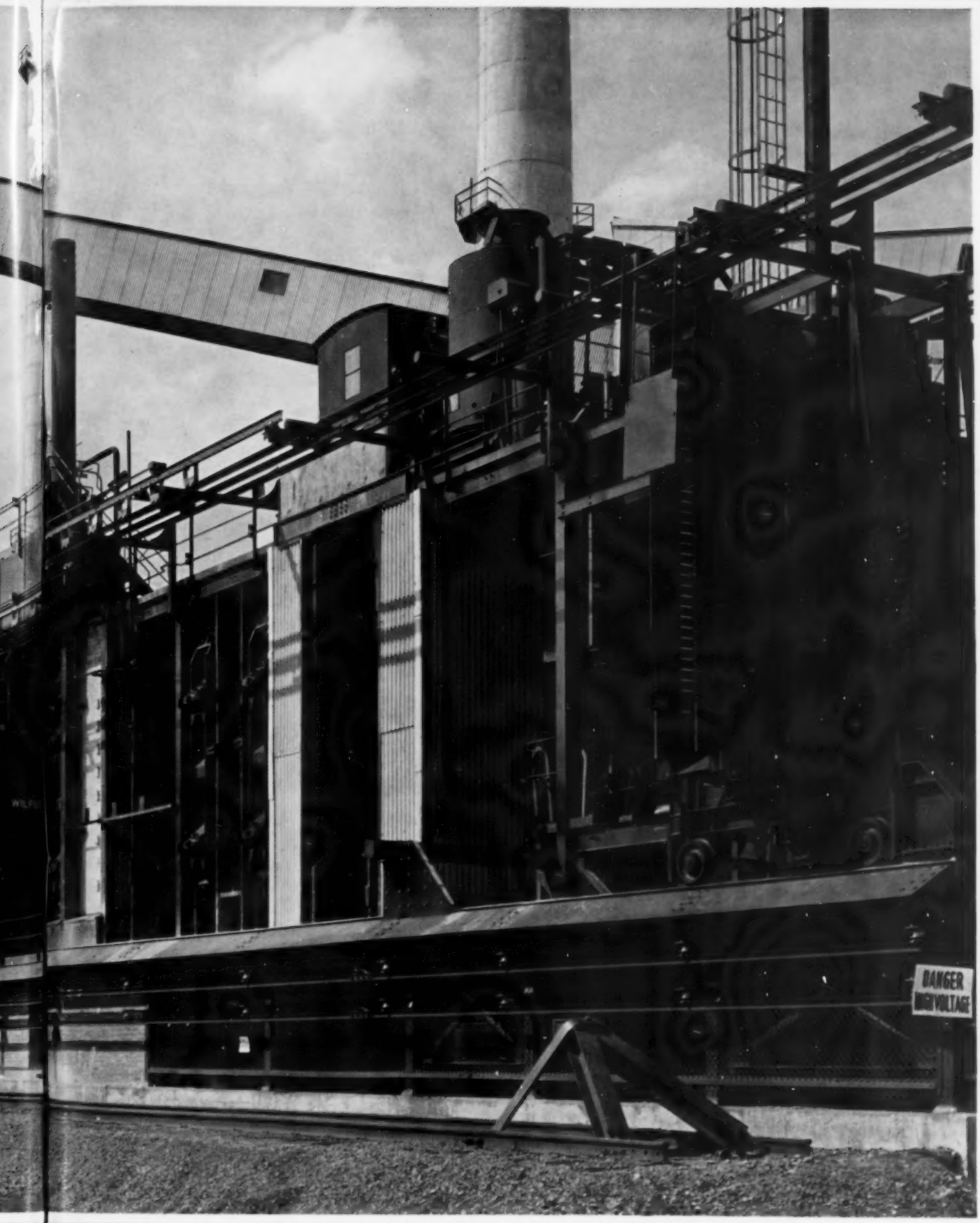
Illinois Heating Specialties

Another Wilputte Battery–

50 underjet coke ovens
with hydraulically operated
self-sealing doors and
equipped for underfiring
with blast furnace gas
placed in operation in
the Chicago District, late 1956.



WILPUTTE



E COKE OVEN DIVISION

LLIED CHEMICAL & DYE CORPORATION, *40 Rector Street, New York 6, N.Y.*

Allied Chemical

Two 30 ton, 75 ft. span Bedford magnet cranes with 15 ton bucket auxiliaries working over the cinder yard—used as skull crackers in Detroit Steel Company's mill at New Boston (Portsmouth), Ohio.

Bedford Steel Mill Cranes are individually engineered for each specific application

In steel mills, power plants and throughout heavy industry, wherever superior performance is *expected*, experienced owners are enthusiastically recommending Bedford cranes.

Further proof of the superiority of Bedford cranes is found in the high percentage of *repeat orders* from important owners through the years.

Built to the most modern standards and backed by more than 52 years of specialized crane building *and utilization* experience . . .Bedford cranes have won fame the world over for advanced design and for safe, smooth, dependable performance.

Available in all types and sizes . . . from 5 tons to 350 tons, and up, for all kinds of indoor and outdoor services . . . each Bedford crane is individually engineered and precision built for its specific application.

You are invited to consult a Bedford engineer on your next crane problem . . . with all the facts on the table we believe you too will make your next crane a Bedford.

New York Office: 30 Church St.
New York 7, N. Y., Phone COrtland 7-1897

Pittsburgh Office: Oliver Building, Room 1141
Phone ATlantic 1-0136

STEEL MILL CRANES BEDFORD

BEDFORD FOUNDRY & MACHINE COMPANY, INC. • BEDFORD, INDIANA

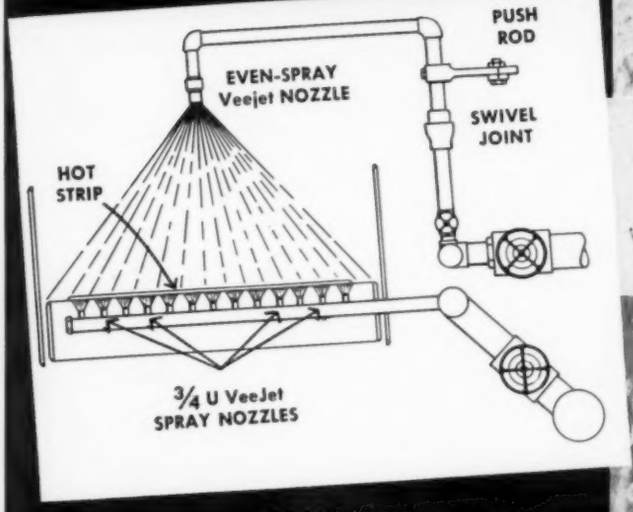
SPRAYING SYSTEMS

SPRAY NOZZLES

FOR

Hot Strip Spray Cooling

• AND ROUGHING STAND ROLL COOLING, **DESCALING** AND RELATED SPRAYING OPERATIONS



AT THE

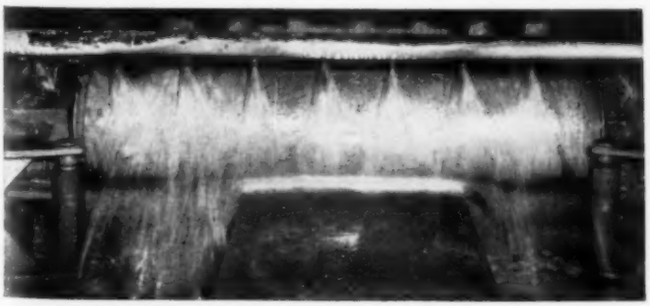
PORTSMOUTH DIVISION PLANT

PORTSMOUTH, OHIO OF THE

DETROIT STEEL CORPORATION

• Large capacity Even-Spray VeeJet Spray Nozzles are mounted above the cooling table. Each nozzle covers entire strip width . . . provides 170 GPM at 80 psi. Smaller VeeJet nozzles are mounted in manifolds below table; capacity of each nozzle is 14 GPM at 5 psi.

• One of the most interesting nozzle installations at Detroit Steel's Portsmouth plant is the system for cooling hot strip. Using Spraying Systems nozzles above and below the first 120′ of the 360′ runout table length, effective steam barrier penetration helps reduce strip temperature as much as 500 degrees between finishing stand and coiler. Cobbles cannot endanger the system since the overhead nozzles are gang mounted on risers with swivels, and swing out of the way when necessary. Not one nozzle has been lost or replaced in over six months of operation. For greater efficiency and lower costs, Spraying Systems nozzles are also employed in such other applications as descaling . . . and roll cooling as shown at left. For complete information on Spraying Systems spray nozzles, we invite your inquiry for Catalog 24 . . . or for the special data sheet folder "Steel Mill Applications."

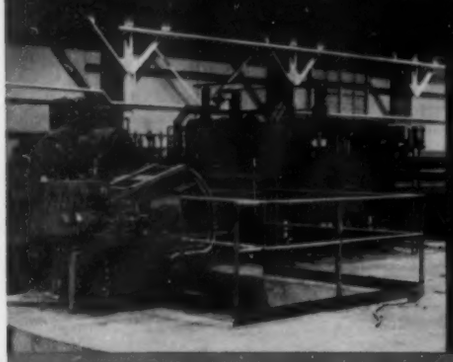


SPRAYING SYSTEMS CO.

3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

TSP slitter mandrels and pinch rolls on 48" slitter

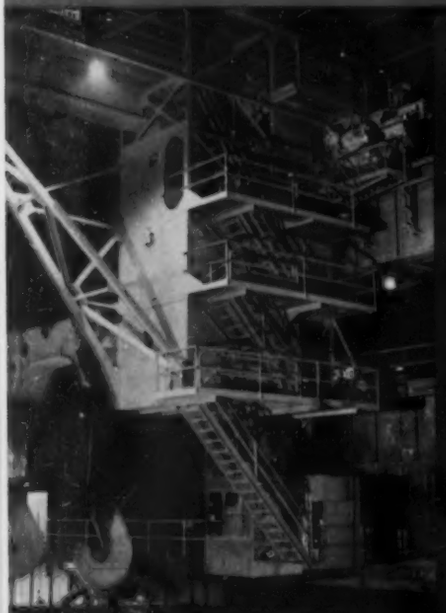
TSP crimping rolls on scale breaker



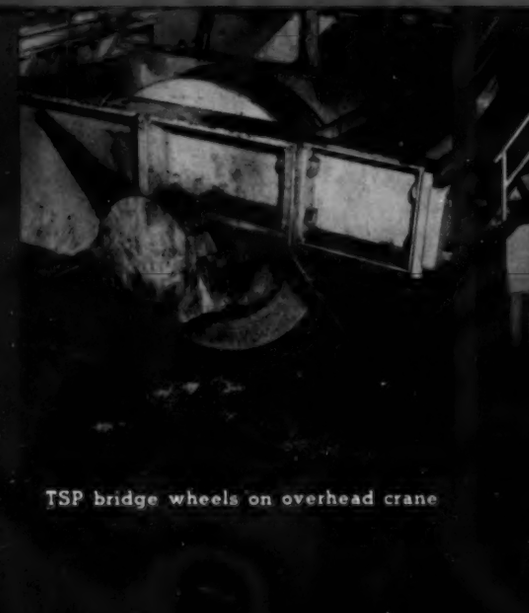
TSP trolley wheels on 30 ton overhead crane

TSP

all



TSP wheels, gearing on 350 ton ladle crane



TSP bridge wheels on overhead crane

TSP bevel gears on mill table rolls

The World's Standard of Quality Since 1909 for Gears • Pinio

AD 1023—Printed in U.S.A.

TSP wheels on ingot transfer car

TSP wheels, gearing on 400 ton stripper crane

TSP gears, pinions, wheels on open hearth charging machine

llover DETROIT STEEL

TSP hardened products...that's right. They're all here – "Tool Steel Process" gears, wheels, rolls, drums, crane wheels, bevel gears and many others – in practically every operation of Detroit Steel's Portsmouth Division at Portsmouth, Ohio.

TSP proven superiority, established by service tests in the nation's leading steel mills, is the reason. TSP products are specifically designed, produced and guaranteed to out-perform, outlast any competitive product. A special hardening process achieves a file hard surface to the full depth of permissible wear, combined with a core refined for toughness and ductility.

If you're interested in keeping your equipment running better and longer, you'll want to know more about TSP hardened products. Write today for complete information.

General view— blooming mill department

TSP gears in manipulator gear box drive

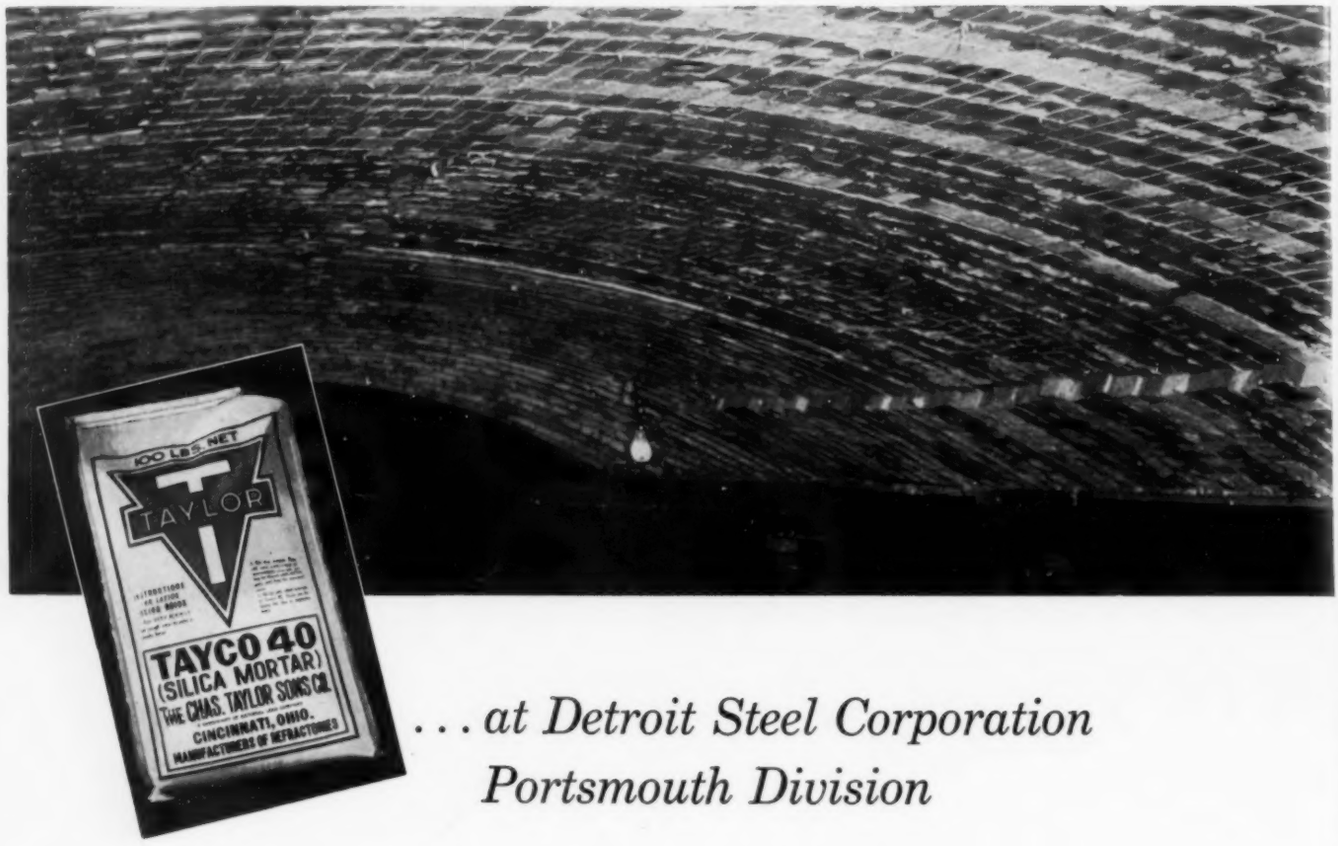
Pinions • Rolls • Wheels • and Other Hardened Products

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U. S. A.

AGMA

Tayco 40 BONDS THE ROOFS...

Photograph courtesy of Detroit Steel Corporation



. . . at Detroit Steel Corporation Portsmouth Division

The Portsmouth Division, Detroit Steel Corporation—as well as other leading steel mills in the United States—is using Tayco-40 High Temperature Silica Cement to improve the life of silica open hearth furnace roofs.

Tayco-40 is nearly as refractory as the best grades of silica or super-duty silica brick. Because of its superior water-retention properties, Tayco-40 is smooth working—remains plastic longer—making it easy to lay brick with thin, tight joints. These properties are obtained without the addition of plastic fire clays found in most silica cements.

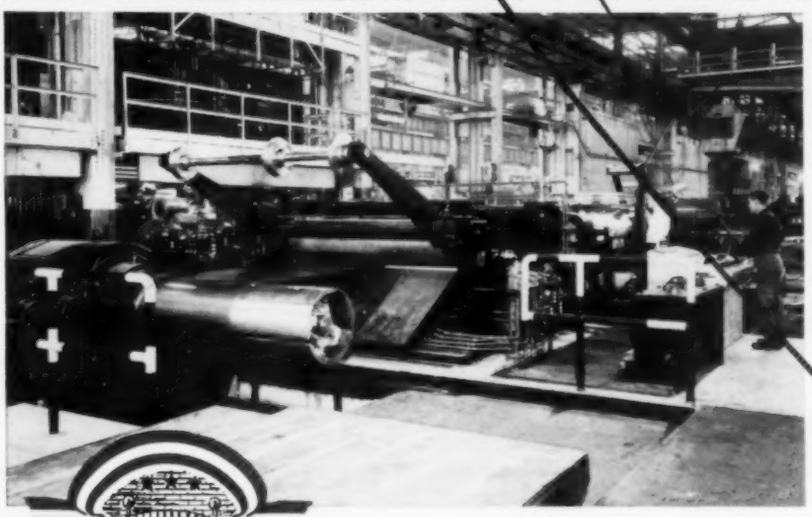
If your open hearth shop has not yet tried Tayco-40, see the Taylor field engineer in your district or write direct for a sample and copy of Bulletin No. 507.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

TAYLOR ZIRCON — TAYLOR SILLIMANITE

The CHAS. TAYLOR SONS Co.
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REG. U. S. PAT. OFF.
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U. S. A.

One of the largest slitting & coiling lines



**60,000 pound, 75 inch wide—
Slitting and Coiling Line**

Years of experience have given us the ability to furnish equipment to meet every slitting and coiling requirement. Bulletin SC55 gives our complete story. Ask for it on your letterhead. No obligation.

Photos show Stamco slitting and coiling unit in cold strip mill

• LAY YOUR SLITTING PROBLEMS AT STAMCO'S DOOR •

STAMCO, Inc., New Bremen, Ohio

IRON LUNGS
provide
Better Breathing
FOR BUSY BUILDINGS
at

Detroit Steel Corporation
Portsmouth Division ***Portsmouth, Ohio***

Progressive concerns, like Portsmouth Division, Detroit Steel Corporation, realize a good efficient worker, to put forth his best effort, must have clean, fresh, comfortable air. That's the kind of air IRON LUNG roof ventilators are bringing to thousands of workers everywhere.

These three photographs clearly indicate how smoke, steam, etc., are drawn to the ceiling and expelled through the roof of two of several departments of Portsmouth Division, Detroit Steel Corporation, by IRON LUNG roof ventilators. The polluted air is thrown so high that these impurities cannot return through open doors and windows.

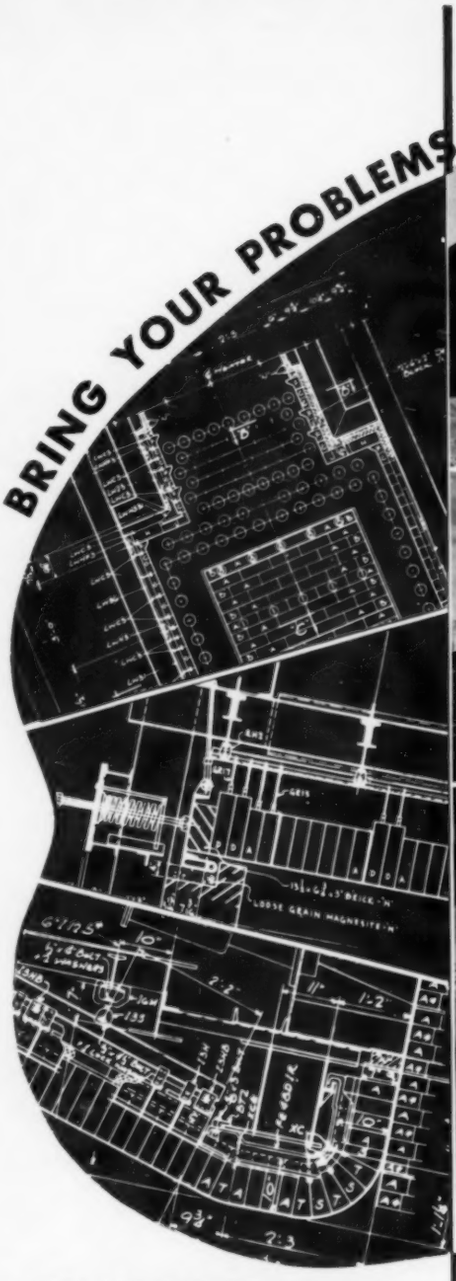
If you are having ventilating problems write us immediately. Don't hesitate, do it now! Our experienced ventilating engineers are at your disposal. We will also be glad to send you catalogs and data sheets. There is no obligation.

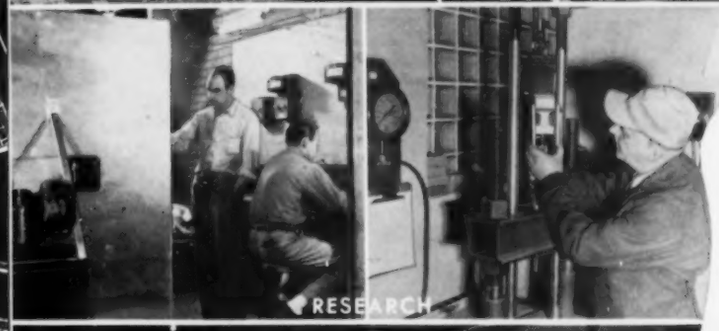
IRON LUNG VENTILATOR COMPANY
5403 Prospect Avenue **Cleveland 3, Ohio**

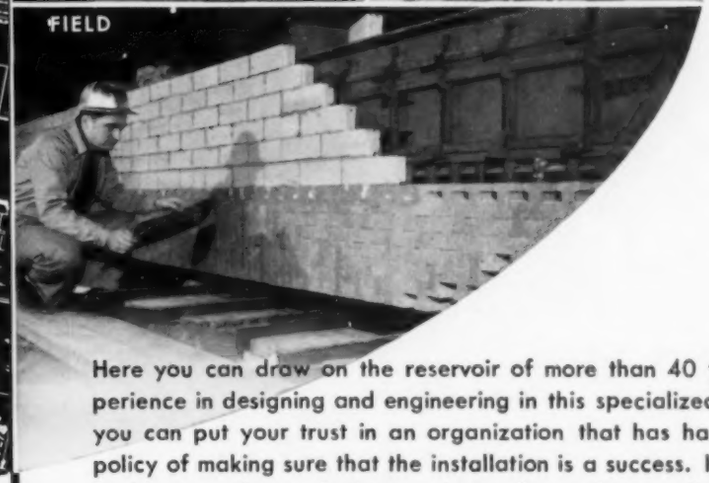
TRADE MARK REGISTERED
IRON LUNG
FOR INDUSTRIAL BUILDINGS

IRON LUNG

BRING YOUR PROBLEMS TO HEAT ENCLOSURE HEADQUARTERS







Here you can draw on the reservoir of more than 40 years of experience in designing and engineering in this specialized field. Here you can put your trust in an organization that has had a life-long policy of making sure that the installation is a success. Here you will find heat enclosure designs engineered to make use of the latest developments of materials and methods.

TEMPERATURE PROBLEMS. Detrick constructions provide for a wide range of temperature requirements from open hearth furnaces through oil refinery heaters to hot gas flues.

HEAT LOSS PROBLEMS. Block and castable insulations as an integral part of Detrick designs cut heat loss to a safe minimum.

CONTOUR PROBLEMS. Detrick supported roofs and walls provide the structural flexibility to meet any contour or span.

M. H. DETRICK COMPANY
111 W. Washington Street • Chicago 2, Illinois

When the new open hearth shop at Portsmouth was designed, Loftus Engineering Company selected Detrick construction for upstakes, fantails and checker roofs. When an additional unit was required the same construction was specified.

DETRICK Heat ENCLOSURES

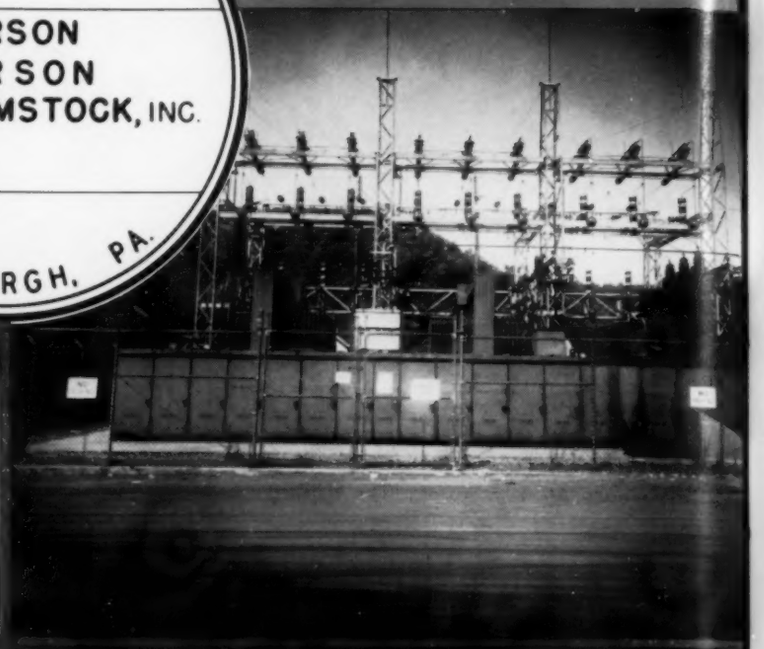
DETRICK
HEAT ENCLOSURES

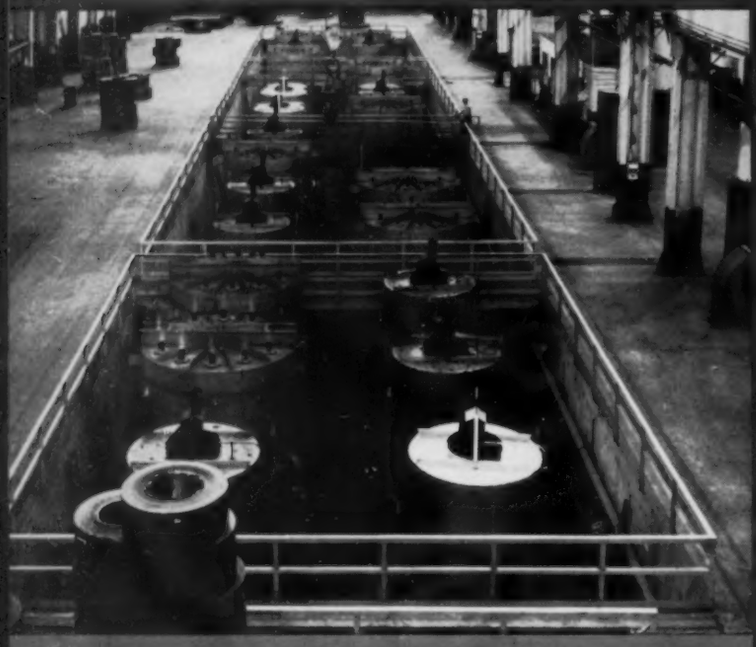
Detroit Steel Corporation — **Portsmouth, Ohio**

ELECTRICAL INSTALLATIONS

PATTERSON EMERSON COMSTOCK, INC.

PITTSBURGH, PA.





COMPREHENSIVE RESPONSIBILITY for the modernization and expansion of the Portsmouth Plant, first assumed five years ago and still being discharged faithfully and efficiently.

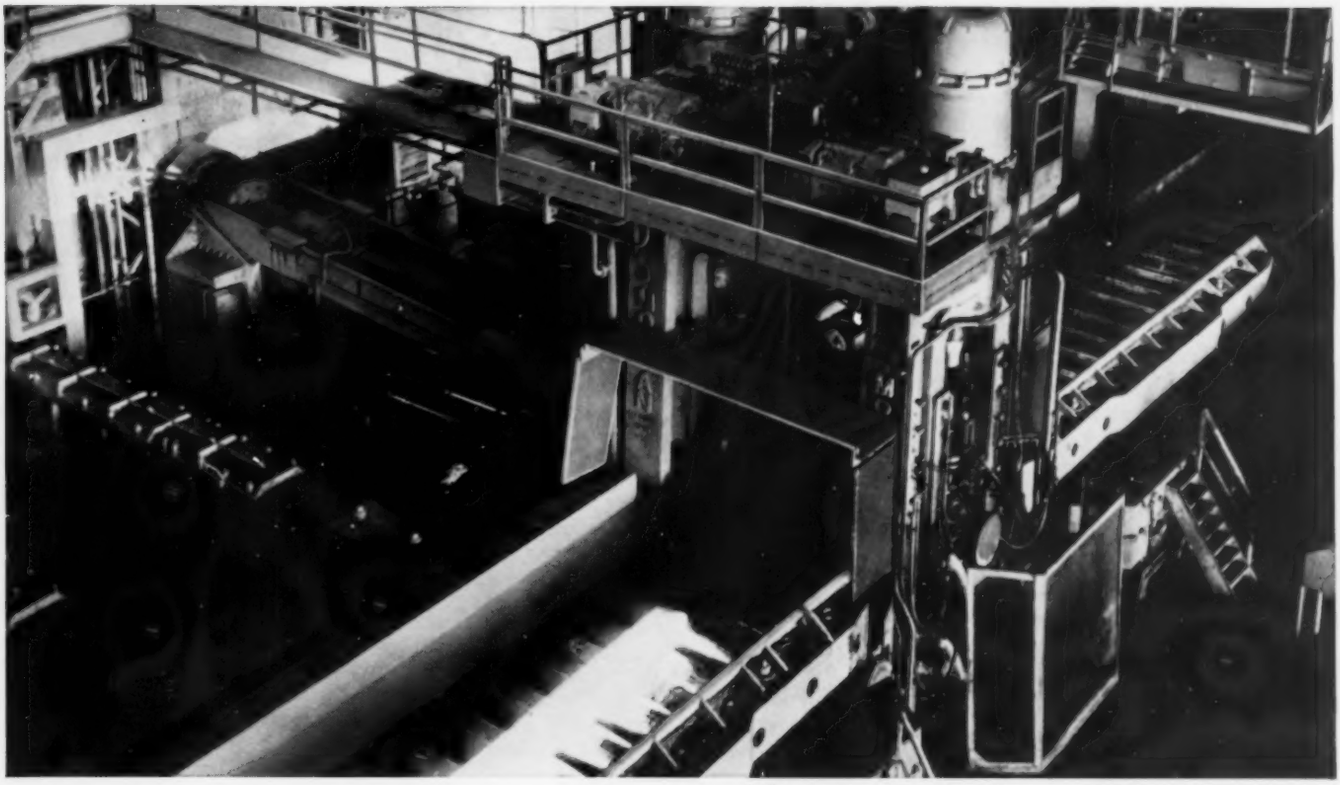
PATTERSON-EMERSON-COMSTOCK, Inc.

313 E. CARSON ST. PITTSBURGH 19, PA.

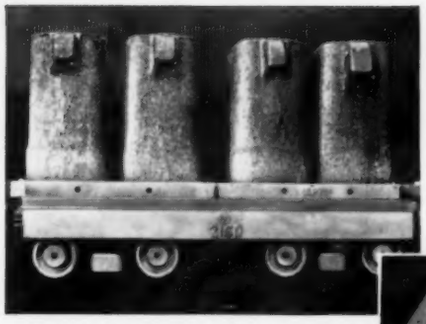
OFFICES IN PRINCIPAL STEEL PRODUCING CENTERS

DETROIT STEEL, PORTSMOUTH DIVISION

Portsmouth, Ohio



44″ blooming mill roll tables are completely HYATT equipped



All four-wheel ingot buggies have two HYATT Roller Bearings per journal

Another progressive plant that

HANDS THE HEAVY LOADS TO HYATTS!

Roll tables of the 54″ hot strip mill are fully equipped with HYATTS

HYATT Roller Bearings are installed on all open hearth charging box cars

In addition to the key installations pictured above, all mill motors are equipped with HYATTS, too. Like so many other leading steel producers, Detroit Steel Corporation can't afford to depend on anything less than the *best* in roller bearings. *Can you?* Hyatt Bearings Division, General Motors Corporation, Harrison, N.J., Pittsburgh, Detroit, Chicago and Oakland, California.

GM GENERAL MOTORS

Watch "WIDE WIDE WORLD" Sundays on NBC-TV

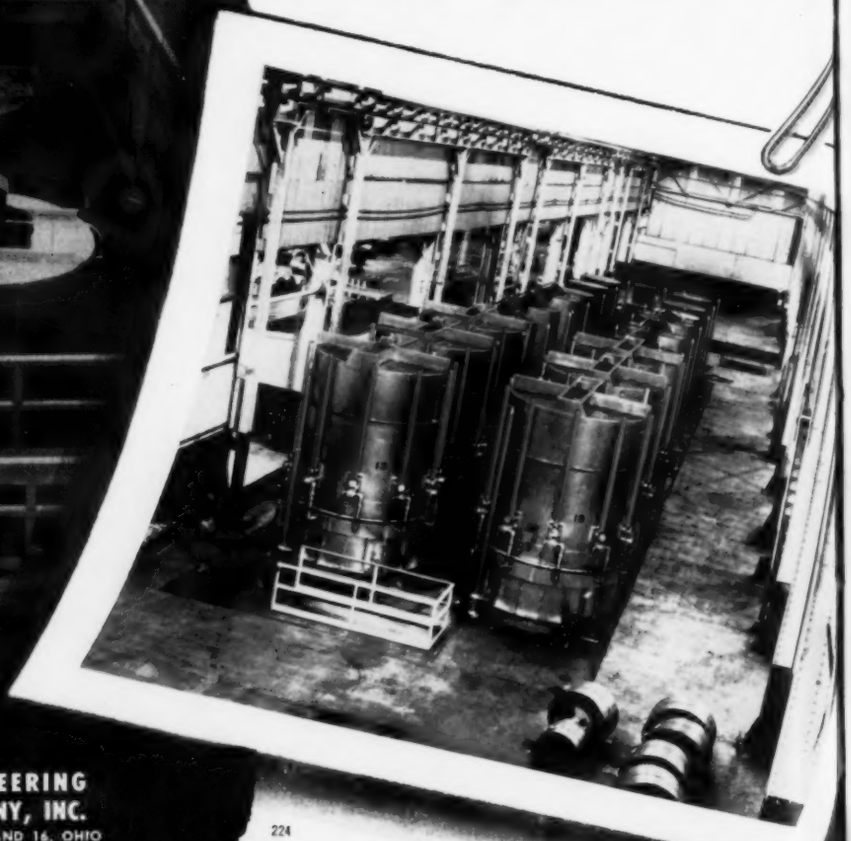
HYATT *HY-ROLL BEARINGS*

FOR STEEL INDUSTRY

Detroit Steel, too, standardizes on Lee Wilson* Single Stack Furnaces

The Detroit Steel Corporation is another of the nation's leading steel producers that has standardized on Lee Wilson Single Stack Annealing Furnaces. In their Detroit, New Haven, and Portsmouth plants, Detroit Steel has found these modern Single Stack Furnaces enable them to make every charge they process a special charge. The flexibility of this Single Stack equipment results in faster deliveries of a wider variety of steel specifications—and, thus, outstanding customer service!

Why not have a Lee Wilson annealing engineer show you how, like Detroit Steel, your annealing practice can be improved by standardizing on Lee Wilson SINGLE STACK Furnaces.



224

Shown above are two views of Detroit Steel's Portsmouth annealing department. It consists of 18 Lee Wilson Furnaces and 48 bases.

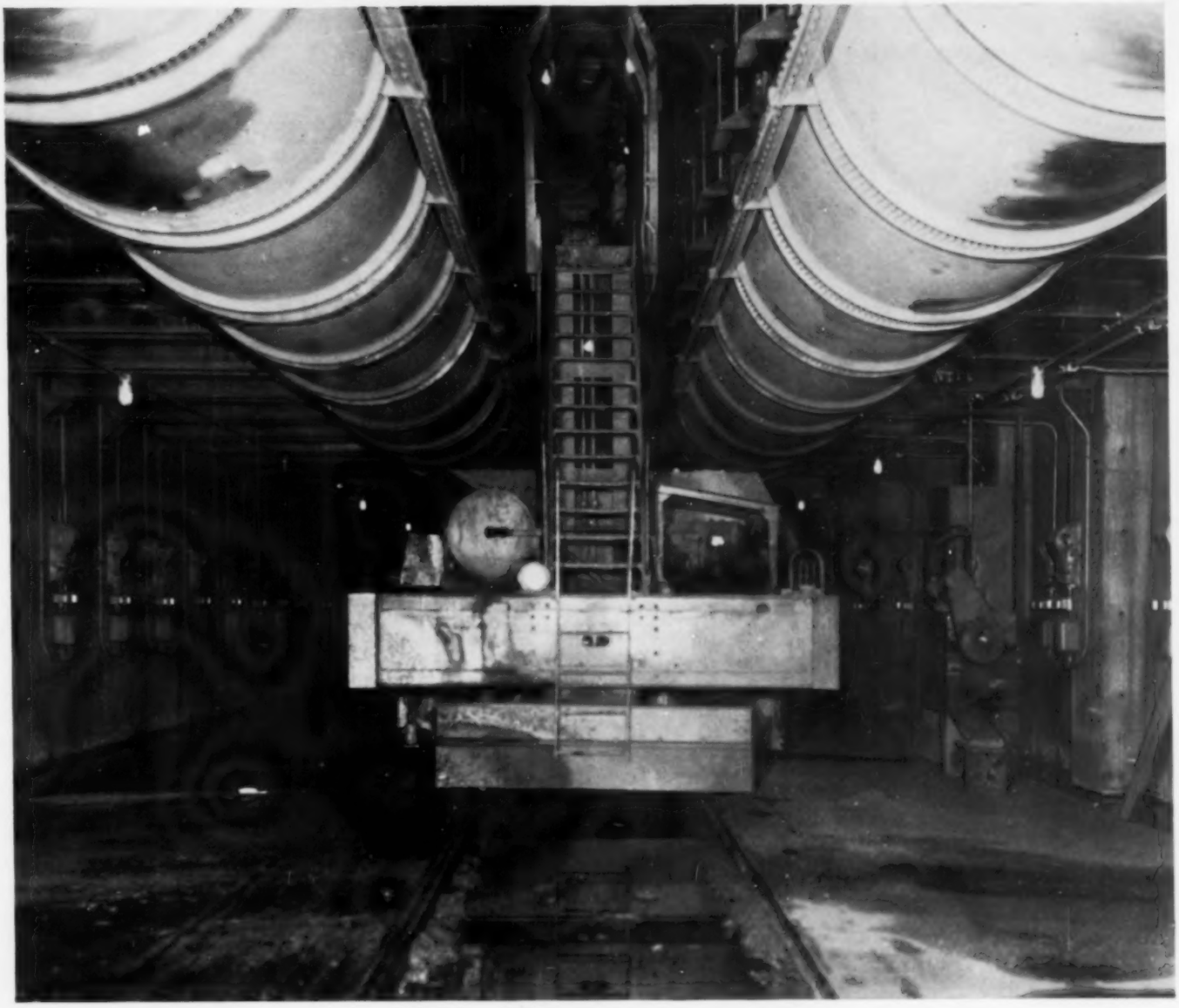
Lee Wilson* ENGINEERING COMPANY, INC.

20005 WEST LAKE ROAD • CLEVELAND 16, OHIO

SINGLE-STACK RADIANT TUBE ANNEALING FURNACES

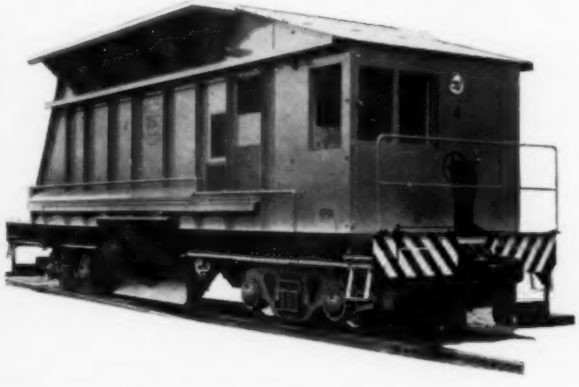
MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF SINGLE-STACK RADIANT TUBE FURNACES



ATLAS CARS SERVING DSC'S NO. 2 FURNACE

at Portsmouth



Unusual stockhouse view above shows the front end of the Atlas Scale Car as it receives a burden from overhead bins. At the left is the 75-ton diesel-electric ore transfer.

ATLAS CAR & MFG. CO.

1140 Ivanhoe Rd. Since 1896 Cleveland 10, Ohio

At Portsmouth Division
DETROIT STEEL CORP.

14 WELDCO Pickling Hooks

Still "Going Great" after 8 Years' Service!

Amazing, but true! In Detroit Steel's Portsmouth Plant, 14 WELDCO Monel Pickling Hooks are still giving satisfactory service . . . 8 years after installation. That's because WELDCO hooks — like the ones shown above — are especially built for long, heavy-duty service. These sturdy hooks are lightweight but tough . . . handle payloads up to 4,000 pounds, are exceptionally corrosion-resistant, and outlast heavy cast hooks 2 to 3 times.

WELDCO hairpin hooks are used in many other steel plants, too, because their superior design makes them readily adaptable to all types of handling equipment. Let us show you how to cut pickling costs and improve your production methods. Your phone call or letter will bring complete information on WELDCO hooks . . . the hooks made for long, economical, heavy-duty service!

WELDCO **THE YOUNGSTOWN WELDING & ENGINEERING COMPANY**

3722 OAKWOOD AVE. • YOUNGSTOWN 9, OHIO

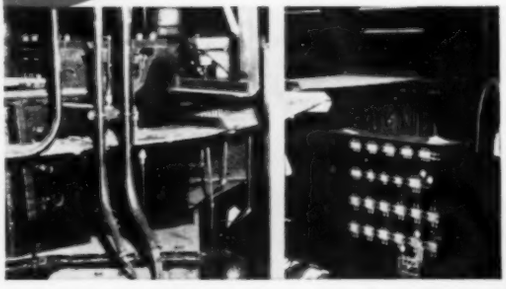
At right—*The 54" hot strip mill at Portsmouth, whose 1466 bearings are protected by 16 manual and 4 automatic Farval systems of centralized lubrication.*

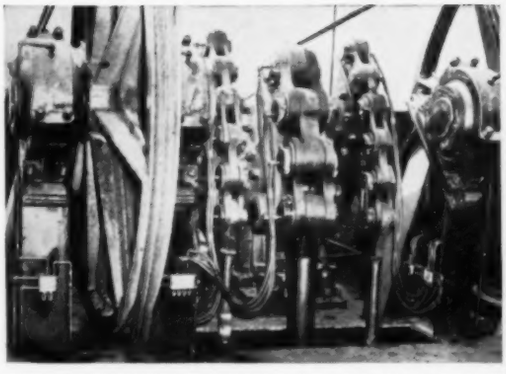
FARVAL at Detroit Steel's Portsmouth Works

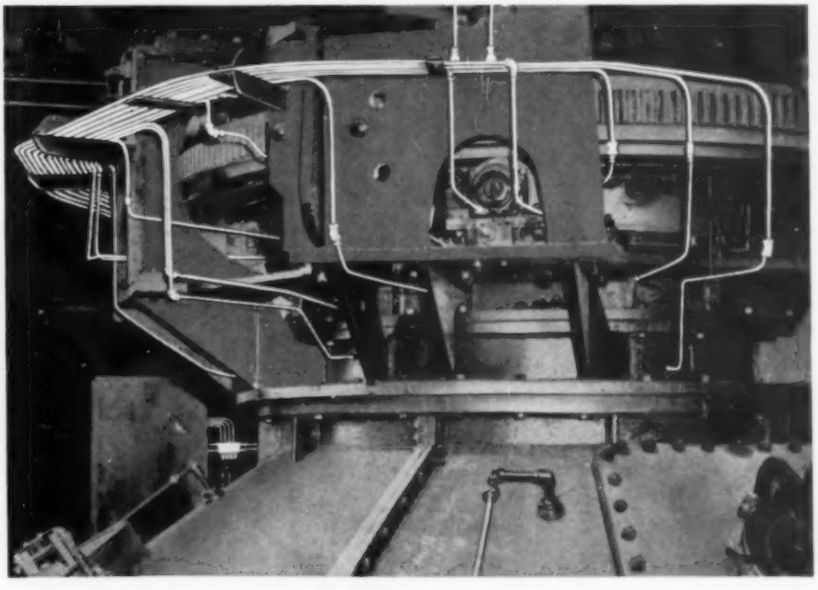
23 Farval systems protect 1757 bearings at the Portsmouth Works—1466 on the 54" hot strip mill and its equipment and 291 on blast furnace No. 2.

Detroit Steel Corporation is one of 28 major steel producing companies that employ Farval Centralized Lubrication—both automatic and manual—to protect the bearings of furnaces, mills, coilers, levellers, welders, trimmers, cranes, conveyors and other machines essential to the production and processing of steel.

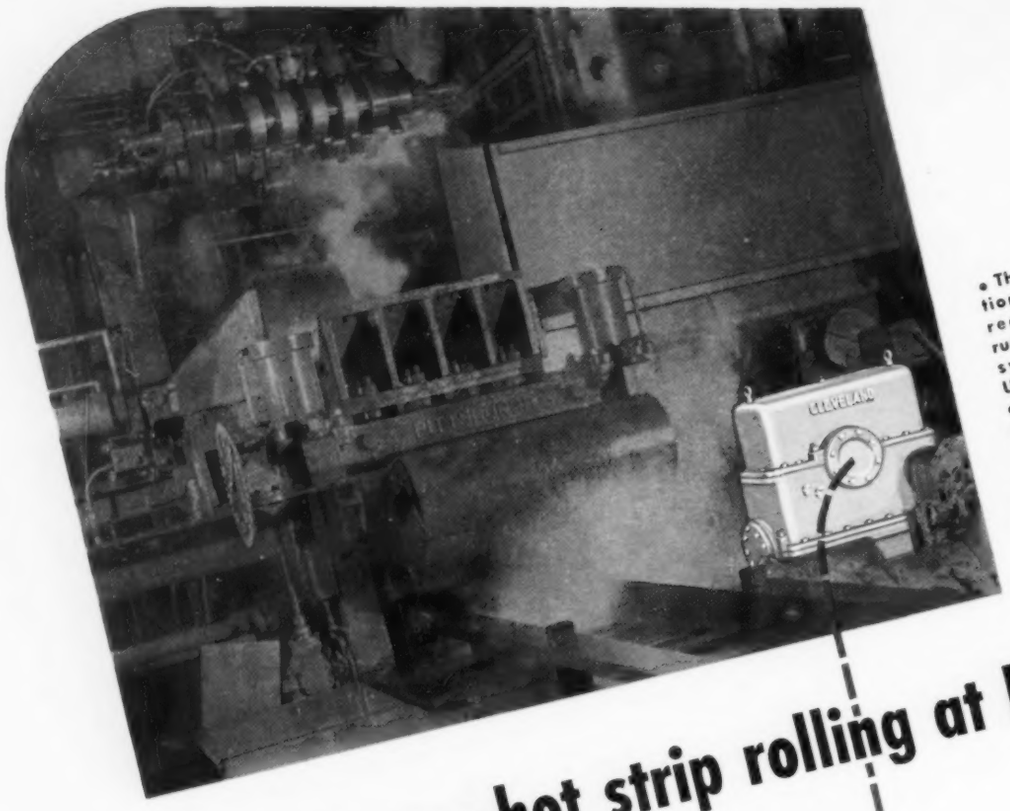
Here as in nearly every steel plant, Farval Centralized Lubrication, backed by a well-trained force of experienced field representatives, is on the job to help produce America's steel more efficiently and at lower cost. The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.







Right and above—*Blast furnace No. 2 at Portsmouth, protected by 3 Farval Automatic Systems. They lubricate revolving distributor (57 points), sheaves, bell beam and links (42 points) and coke breeze conveyors (192 points).*



• This Cleveland double reduction unit provides complete reduction—96.6:1—in one rugged housing with one oiling system. It is driving a Coil Upender at the Mandrel type coiler which coils hot strip (18" minimum to 49½" maximum) into coils 38" minimum O.D. to 54" maximum O.D. Photo courtesy of Pittsburgh Engineering and Machine Co.

CLEVELAND keeps hot strip rolling at Detroit Steel

YOU can find Clevelands on the tough jobs—always driving smoothly. So trouble-free are they that maintenance men call them "always dependable." That's why Cleveland worm gear speed reducers are specified for exacting jobs like this one—driving the expanding mechanism for this hot strip upcoiler at Detroit Steel's Portsmouth (Ohio) Division.

Cleveland features the case-hardened steel worm that meshes with nickel-bronze gear. This combination gives up to 50% increased resistance to shock and wear. Parts are enclosed in an oil bath in a dirt-tight housing. Result is long life—Clevelands installed back in the twenties are operating as efficiently today as when they were new. And Clevelands *cost no more* than an ordinary drive.

If you are a builder or a user of equipment that must have a dependable drive, be sure to get the presentation of the complete Cleveland line. Write for Catalog 400. The Cleveland Worm and Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

EVALUATION AND SPECIFICATION OF

PAINT FOR INDUSTRIAL USE

By

JOSEPH BIGOS,

Senior Fellow, Mellon Institute*

and

Director of Research*

Steel Structures Painting Council

Pittsburgh, Pa.

▲ TO achieve economical protection in the painting of industrial plants, the protective coating must be thought of as a complete system which embraces the underlying steel surface. It immediately follows that the surface preparation, the pretreatment, the primer, intermediate and finish coat must be evaluated on the basis of the complete system. Putting it another way, the cleaning methods used must be adequate for the type of primer that is to be used. In turn, the primer and finish coats must be compatible with one another in addition to the primer being compatible with any type of pretreatment applied over the cleaned surface. Failure to follow this basic philosophy results in incompatible systems of varying degree with perhaps premature and costly failure of the paint.

The first point to be decided is whether the painting of a new plant or the repainting of an older one is going to be primarily for appearance, primarily for protection, or is going to incorporate both ideas. Although many old plants do not lend themselves to highly decorative painting such as the color conditioning which is in great vogue today, one of the most attractive bonuses which comes from a good understanding of painting procedures is the good appearance obtainable at little or no increase in cost above protective painting alone.

When the paint shall be required to serve in both a decorative and a protective capacity, a sound evaluation is necessary to determine which paints are capable. In the past, this program has revealed striking variations in ability between well-known trade names of paint with little variation in cost. Based upon a sound evaluation program, a specification may be prepared for a particular paint or the entire program and procurement of paint simplified. Specifications for paint generally lead to considerable reduction in the cost of paint without sacrifice in quality provided, of course, reputable suppliers are used who will not sacrifice quality for cost. The specification may be a performance type of specification in which brand name paints of varying composition may be supplied, or the specification may be a composition type giving the formula of the paint with some performance tests. Regardless of the specifications, the detail and thought that goes into its preparation and the follow-up control procedures, no specification is complete protection against accidental or sometimes deliberate submission of poor quality materials. Again, it is emphasized that specifications appear to be the best way of purchasing paint, but price alone should not be the criterion of judging which supplier should receive the order.

....in painting, one goal should be kept in mind: to obtain the best possible coating with the longest life at the least practical costs.... initial paint cost is not the criteria for economical coating....paint life must also be considered ....and paint cost probably represents only one-fourth of the total painting costs....

From the outset, it must be borne in mind that the most desirable protection is that which has the lowest cost per square foot of surface per year. But since the low initial cost painting often results in short life, the high cost methods may be the most economical because their life is much longer. It is a fallacy to think painting cost is proportional to the cost of the paint in dollars per gallon. In the general case, the cost of the paint represents only about one-fourth of the total painting costs. A large increase in paint cost may affect

* At time of paper presentation; now Head, Organic Coating Section, U. S. Steel Corp., Applied Research Laboratories, Monroeville, Pa.

the total paint cost only slightly. Painting costs may be calculated using the methods of Adams (1).† Capitalized cost of painting presents a different picture than a comparison of direct costs due to interest on investment and loss of potential revenue. To be economical, a painting system which costs twice as much as another must have more than twice the life.

The most important factors determining the actual service life of paint are:

1. Design
2. Surface preparation
3. Application
4. Paints

These factors must be considered in any program where the objective is to evaluate paints for use in an industrial plant.

Proper design by attention to detail will minimize corrosion and paint failure and will facilitate repainting. Proper design utilizes the most suitable metallic substrate, eliminates crevices, joints, galvanic couples, pockets, sharp edges, and other items too numerous to mention.

Surface preparation determines the life of a paint to a greater degree than any other factor. Hot rolled structural steel has a layer of blue millscale, which is a mixture of iron oxides. This millscale, when intact, provides a good base for painting if the steel will not be immersed in strong electrolytes, such as salt solutions. Upon handling, fabricating and exposure to the weather, millscale becomes cracked and broken and, in the weathering process, becomes undercut by rust so that the scale lifts from the surface. As a result the millscale is often partially undercut by rust and will sometimes lift after painting making a poor surface for painting. The procedure of weathering to remove millscale is not recommended unless it is followed by blast cleaning to remove the rust.

Rust probably is the worst surface to paint over. No known method of painting has been completely successful when rust is the substrate, despite *all* advertising claims to the contrary. Removal of rust is mandatory, even though comparatively ineffective methods such as chipping and hand wirebrushing are used. Weathering to remove millscale is sometimes desirable when blast cleaning or pickling are not feasible and the steel is to be later exposed in a strong electrolyte where devastating corrosion could occur at breaks in the millscale.

For normal atmospheric exposures or mild yard areas, conscientious hand or power tool cleaning to remove loose millscale and rust as well as oil, grease and soil is adequate as the surface preparation—provided primers of sufficient wetting ability are used. This type of primer would be a slow-drying linseed oil paint. It is not necessarily the most economical method when figures are for the cost per square foot per year, but it results in a lower initial painting cost. When the structure becomes stabilized so that no millscale lifting occurs, the life of the protection becomes a function of the durability of paints. Repainting may be governed by other considerations such as appearance.

In extremely corrosive areas, blast cleaning to white metal is almost mandatory for long service life. As

† Numbers refer to Bibliography at end of article.

Figure 1 — Illustration shows how a wetting oil pretreatment will improve performance of paint on rusty steel or broken mill scale. Portion on the right of line has been treated with wetting oil.

the severity of the exposure decreases, commercial blast cleaning, brush-off blast cleaning, flame cleaning and less effective methods may be adequate. Steam cleaning may be used to great advantage in industrial plants to remove soluble corrosive salts, acids, bases, oil, grease, dirt and soil. Even old paint strips off using paint removers in place of the milder detergents.

Application of paint in a correct manner insures maximum paint life commensurate with practical difficulties. Application is second in importance to surface preparation. Perhaps the most important and essential feature of good application is to obtain adequate dry film thickness. Improper thinning of paint makes it difficult, if not impossible, to obtain adequate thickness because thinning decreases the viscosity, makes the paint easier to apply, and increases coverage. Paint should be applied at the viscosity recommended by the formulator or manufacturer of the paint. Spraying may require further dilution with thinner. The first detailed guide for adequate inspection of cleaning and painting, "Good Painting Practice" (2) has recently been published. The surface should be clean and dry when painted. If some time has elapsed since cleaning, the surface should be checked for further deposits of dirt or other contaminants. Painting should take place prior to the formation of any corrosion stimulators such as acid residues, salts and dew which may contaminate the surface between coats of paint as well as prior to painting.

Painting should take place in dry weather with the relative humidity lower than 85 per cent; the air temperature above 40 F; the surface should be dry and at least above the freezing point of water. If there is danger of rain, snow, or freezing temperatures before the paint is dry, painting should be delayed.

Preceding coats of paint should be dry before further coating, but there exists, however, a danger of paint becoming too dry for satisfactory repainting. Fresh linseed oil paints may, upon drying too long, be difficult to wet with subsequent coats of paint and crawling may ensue. Phenolic paints are notorious for drying too hard for satisfactory recoating with resulting poor adhesion of subsequent coats. Proper drying conditions

are advantageous in obtaining long paint life. Obviously it is difficult to control exterior drying conditions in the field as easily as conditions in the shop or indoors. Where possible, paint should not be exposed until it is dried thoroughly. If painted steel is to be immersed in water or exposed to chemicals, the longer the paint is dried before exposure, the better the resulting service.

Paint itself will now be considered. The first requirement for a paint or coating is that the material be adequate to perform the services expected in the environment and on the type of structures to be protected. A suitable selection must be made of primer, intermediate and topcoats. The primer must have the correct pigments for inhibiting corrosion; the vehicle must have sufficient wetting ability to develop proper adhesion to the type of surface being painted and *this factor is critical in deciding paint performance.* Most of the highly resistant materials have poor adhesion to steel or require clean steel surfaces free of rust, millscale, oil, grease, dirt or chemicals. Linseed oils and fish oils wet best, but fish oil paints do not stand up too well in industrial plants. Straight alkyds and phenolics wet only fairly well, but are excellent over blast cleaned steel. Lacquer type synthetics such as the vinyls, are poor in wetting ability but strongest in chemical resistance. It is universally true that the best wetting materials are those with the least chemical resistance and vice versa.

If the primer is used as a shop coat, it must be capable of protecting the steel from the time of shipment to the time it is erected and field coated. When field coating or finish coating takes place at relatively short periods after priming, the primer need not have as great weather resistance. The second coat of paint should be one which has some degree of rust inhibiting properties, but it should also have inertness and increased resistance to the passage of water and oxygen. Since it must wet only the primer, the wetting characteristics need not be as strong as those of the primer; faster drying synthetic paints are generally satisfactory. The paint then has improved durability in severe exposures. The outer coat of paint must be pigmented so that the color retention is good when color is important. It must be inert to the atmosphere in which it will be exposed and must serve to protect the paint system from the effects of ultra-violet light and the weather, as well as from chemicals in the plant. Sulphurous gases cause accelerated corrosion in industrial atmospheres. The vehicle obviously must be one which will have long durability in the environment to which it is exposed. If this environment is rural or marine atmosphere, then linseed oil, alkyd or phenolic paints are adequate, but, if the environment is a strong chemical one, then oleoresinous paint may be completely unsatisfactory and synthetics such as vinyls, chlorinated rubber, or epoxies—or inerts such as bitumens—may be necessary.

This brief summary covers only basic fundamentals. Detailed coverage of the painting of steel is found in the two volumes of the Steel Structures Painting Manual (2); attention is directed to the chapter on painting of industrial plants, particularly the section on the painting of steel and coke oven plants by S. C. Frye (4).

Figure 2 — A hot spray application of a bituminous mastic over sandblasted steel results in greatly extended coating life in corrosive areas.

THE EVALUATION PROGRAM

A proper evaluation program considers the basic fundamentals of good painting practice for the type of plant. It considers materials known to have suitable properties for the intended exposure. It leads to specifications or standard plant practice that results in economical protection.

Preliminary analyses—The first step in evaluation of paints for plant service is to look objectively at the problem. Write the specific problem for record purposes. What is to be protected? What are the deteriorating influences to protect against? Is severe exposure involved? Much of the painting around an industrial plant is not severe exposure. Yard areas can use oil base or alkyd paints. Stronger corrosive exposures may be adequately resisted by phenolic varnish paints. Strong fume exposure such as around pickling tanks and coke oven plants may require vinyls, epoxies, chlorinated rubber or similar synthetics. Coatings subjected to splash or spillage must have much more resistance to the chemicals involved. For direct immersion the greatest resistance to chemical or solvent attack and the greatest thickness of coating are required in fact, linings are often used. What temperatures are involved? Increase in temperature drastically shortens the life of most coatings, particularly in the case of complete immersion. Table I lists factors to consider in a preliminary analysis for selecting ma-

TABLE I
Preliminary Analysis Data Desired

1. Surface to be protected.
2. Location.
3. Composition of surface to be protected.
4. Total surface area involved.
5. Present condition of surface.
6. Present paint or other coatings on surface.
7. Case history and life of previous coatings.
8. Is blast cleaning permissible in the area?
9. Are explosive gases present?
10. Is adequate ventilation possible?
11. List chemicals or solvents present and whether exposure is fume, splash and spillage, or immersion.
12. Length of contact with above.
13. Concentration and temperature of chemicals or solvents.
14. Average humidity of atmosphere.
15. Average temperature of atmosphere.
16. Maximum temperature of surface to be coated.
17. Is surface exposed to weather?
18. Is condensation present?
19. Is steam present or used for cleaning?
20. List special conditions, such as abrasion, mildew, product contamination.
21. What colors are necessary or preferred?
22. What methods of application are permissible?
23. How much time is available for working?
24. List previous materials known to be unsuitable.
25. Suggest materials for trial.

terials suitable for test. All data will not be available, but even a little will be of great value in helping select paints.

The importance of an adequate preliminary analysis should not be underestimated. Drastic paint failure can result by overlooking a simple factor. The factors in Table I should be gathered into a reproducible form which is suited to the individual use. The paint engineer charged with responsibility for the evaluation should make the survey and obtain the data. Reliance on plant-operating personnel to fill out forms of slight interest to them is hazardous.

SELECTION OF MATERIALS

Having determined what is to be protected and against what, the next step is selection of materials believed suitable for the application. Suitability requires chemical and physical resistance for the exposure and properties which make satisfactory application possible. These latter properties include adequate wetting of the surface with the type of surface preparation possible or advisable, good adhesion to the surface and between coats, and drying time sufficient to complete painting in the time available.

If the service is extremely severe—such as complete immersion in a hot, highly corrosive liquid—then linings may be required. This is no field for the novice and he should obtain competent technical advice, but he can screen the lining materials recommended to determine which will have the resistance required. Screening may determine recommended linings are inadequate and corrosion resistant construction is mandatory.

Unfortunately, the better the chemical resistance of the resins used to paints and coatings, the poorer the wetting of the surface and resulting adhesion. The materials picked for evaluation should be selected by generic type. Much information has been published on resistances of the commercially available resins and oils to a great number of chemicals and solvents. These references (3), (10), (11), (12), (13), (16), (17), (18), (19), (20), should be consulted to determine the materials with adequate resistance to the specific exposure under consideration. Seymour (10) has published the tabulations in Table II which is helpful as a starter.

In Table II and throughout this work, numerical ratings are given as assessments of the property under consideration. A rating of 10 is the ultimate available or else perfect. Zero indicates worthless or no protection. A rating of 6 is usually considered as the minimum acceptable, but a rating of 8 should be obtained for critical or most important properties. A score is obtained for each material which is the total of the ratings for all properties required. This same scoring procedure is used in the final rating after test results are available. Zahn (21) elaborates in fine detail on this scoring procedure as well as methods of evaluating finishes. In some references, the best material is rated I, so caution is advisable when using published ratings.

Select the generic types of resins with the least rigorous surface preparation and application requirements yet capable of performing well. The cost of the materials should also be considered. Do not make the mistake of selecting a material suitable for the most severe exposure and using it as a standard for all surfaces, since in the general use only a small portion of the plant is subjected to extremely severe attack. Try to strike a compromise between economy of material, maximum protection, and a minimum number of different materials.

The resistance charts referred to are for the resin or vehicle only. Pigmentation must be considered. The pigment portion of the coating must also have satis-

TABLE II
Comparative Resistant Values of Typical Commercial Coating Formulations

Generic name	Sunlight and water	Stress and impact	Abrasion	Heat	Water	Salts	Solvents	Alkalies	Acids	Oxidation	Total
Neoprene	8	10	10	10	10	10	4	10	10	6	88
Vinyl	10	8	7	7	10	10	5	10	10	10	87
Saran	7	7	7	7	10	10	5	8	10	10	81
Epoxy	9	3	6	9	10	10	8	9	10	6	80
Chlorinated rubber	7	7	7	5	10	10	3	10	10	9	78
Styrene copolymer blends	6	6	7	6	10	10	4	10	10	8	77
Furan	8	1	5	9	10	10	10	10	10	2	75
Phenolic	9	2	5	10	10	10	10	2	10	7	75
Alkyd	10	4	6	8	8	8	4	6	6	3	63
Asphalt	7	5	3	4	10	10	2	7	10	2	60
Oil base	10	4	4	7	7	6	2	1	1	1	43

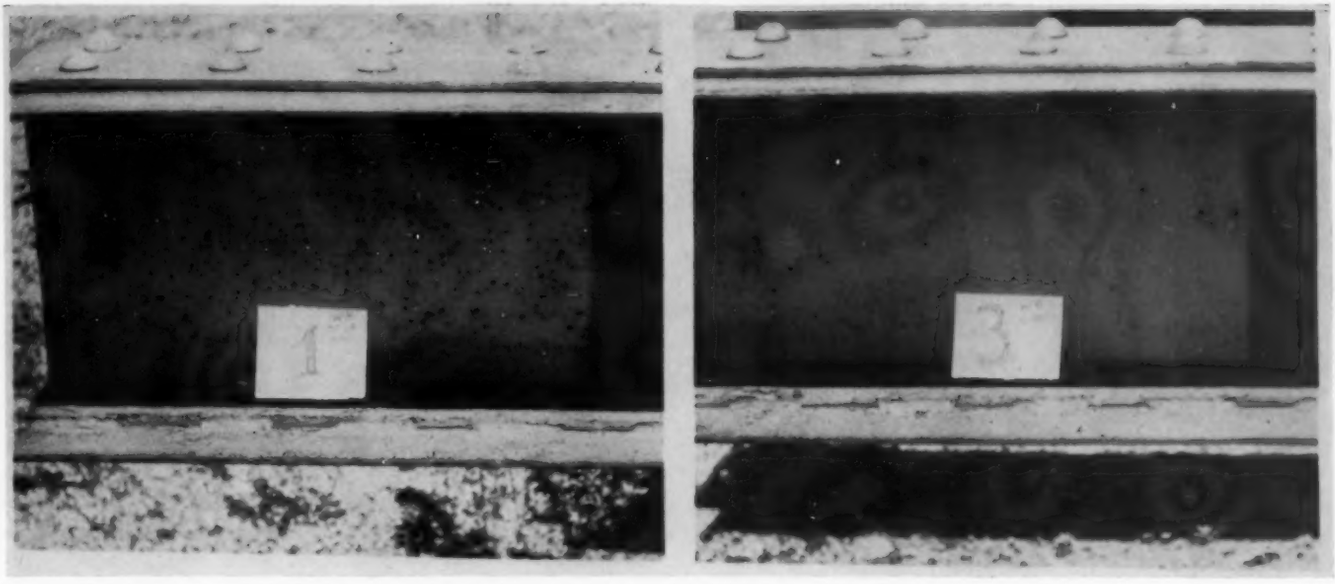


Figure 3 — Rust removers based on cold phosphoric acid detracts from performance of paint on rust and mill scale. Specimen on left has been treated and that on the right has no chemical pretreatment.

factory resistance to the environment. Here, too, there are published references with the desired information (3), (6), (11), (14), (15). Paint primers usually require rust-inhibitive pigments, but in some chemical exposures the best protection is obtained by barrier-type coatings, without rust-inhibitive pigments. In fact, under severe oxidizing conditions red lead or zinc chromate are not desirable since they may lead to accelerated corrosion.

Table III lists the commercially available types of coatings by generic classification based upon the resin. They are listed, approximately, in increasing chemical resistance. At the same time, as chemical resistance increases, application difficulties and costs increase. The materials at the top of the list have best wetting characteristics for millscale, rust, or dirty surfaces. As one goes down the list, better and more rigorous surface preparation is required. The three materials at the bottom of the list are extremely difficult to apply and, at the present time, are practicable only for small items in shop application.

In addition to the above list, there are resins such as the silicones which are excellent for high temperature resistance, rust preventive compounds for temporary use or protected exposures, zinc dust silicates for good temperature and corrosion resistance, thiokols and synthetic rubbers for special applications.

Directories of suppliers are available for coatings (8), (9). Consult technical data sheets and specifications of the manufacturers for specific chemical or solvent resistances and the following data:

Generic type
Specific uses
Surfaces suitable
Cleaning required
Nonvolatile solids content by volume
Coverage in square feet per gallon per cost
Dry film thickness obtained per coat
Cost per gallon

Calculate the cost per mil (0.001 in.) of dry film thickness and the total cost per square foot when applied at the recommended thickness. In working with paints, the term "solids" refers to nonvolatile matter whether liquid or solid. Formulas are generally given in terms of weight per cent. Volume per cent of solids is the critical item and this can be calculated—if the supplier cannot give it—from the weight per cent of volatile and the type of volatile thinner. (See page 97 of reference 3.)

Most specialized or highly resistant materials are available only as proprietary products. Specifications are available for oil, alkyd, phenolic, vinyl and chlorinated rubber paints and bituminous mastics (2). To get the latest and best materials, it is necessary to use proprietary products. The converse is not true, however, since you do not necessarily get the latest and best materials because you use a proprietary product.

View paint manufacturers' claims with doubts and rely upon proof. Be particularly suspicious of any claims for curealls, any that purport to eliminate the necessity for cleaning and any that offend common sense. Reputable paint manufacturers have good technical representatives. The price of proprietary products includes technical assistance—use and profit by it. Finally, do not try to make a paint do a job that calls for a lining.

TABLE III
Commercially Available Coating Binders

Drying oil
Alkyd
Phenolic (varnish)
Epoxy ester
Styrene-butadiene
Asphalt
Coal tar
Chlorinated rubber
Chlorinated hydrocarbons
Epoxy (catalyzed or baked)
Vinylidene chloride
Vinyl
Phenolic (catalyzed or baked)
Furans
Neoprene
Natural rubber
Polyethylene
Trifluorochloroethylene
Tetrafluoroethylene

TEST PROGRAM

After determining the materials which appear to show promise of satisfactory protection against corrosion, a test program for final evaluation selects those most suitable. Different philosophies exist in regards to the type and number of tests to be run and the stages to go through. An outline of a suggested testing program follows. Each engineer must program his own tests in a manner that will yield sufficient valid technical data to permit reaching a correct conclusion to his company's problems. The novice is well advised to carry out as many of these tests as possible. Experience coupled with a working knowledge of the subject and good judgment will gradually eliminate many routine tests and greatly simplify evaluation.

Tests are divided into those which measure physical properties of paint—such as weight per gallon and viscosity—and those which truly evaluate the real merits of a paint to perform its function—such as rust resistance. The first group of tests are quality control tests. They serve to determine the characteristics of the paint so that they can be kept at a satisfactory level in use by standard quality control procedures as discussed by Garner (5). They are used to determine if supplied material meets specification requirements or are up to standards of previously supplied materials.

The first tests which begin to evaluate paint merit are conducted as screening tests; they are short term performance or accelerated tests. Done primarily in the laboratory, they strive to achieve in a short period the results which are obtained in years of service testing or use. To achieve breakdown in a small fraction of the normal time drastic increases in the severity of the exposure conditions are resorted to. Temperature is increased, or concentration increased—perhaps both are raised; perhaps the paint is subjected to intense ultra violet light, high humidity, or salt spray. Since complex materials such as organic coatings are not likely to react in direct proportion to these changes, it is extremely difficult—if not impossible—to get satisfactory correlation of results between short time tests and normal use. Statements that one hour in a certain accelerated test is equivalent to so much time in a real exposure are nonsense. These tests are valuable tools, but the plant engineer or paint chemist using them must be aware of their deficiencies and the limited value of the properties they purport to measure. Coupled with accelerated tests are short term tests such as immersion in specified liquids which test resistance over a shortened period. By extrapolation of the breakdown, the material is judged on its ability to perform in service. An absolute requirement of this type of testing is reproducibility of results. Therefore, all such tests are to be conducted under rigorously standardized conditions and test procedures.

Field tests are conducted on materials found satisfactory in the preliminary evaluation. Field and service tests differ from the laboratory test in the manner of exposure. Coated specimens—of a carefully selected type—are exposed in the actual place of expected usage or an environment known to be identical in all essential characteristics. Field tests generally utilize small scale specimens coated in the laboratory—but not always since some field tests may entail application at the site to test effect of surface and intercoat contamination. Field tests strive to evaluate materials applied under identical conditions to identical surfaces. Conditions are generally ideal.

Figure 4 — In the steel plant, areas such as this are difficult to paint because of the numerous edges, crevices and angles.

Service tests are conducted on the actual structure to be protected. Application is under normal field conditions. There is less control of the variables involved. Accuracy of results derives from the large scale operations which tend to compensate for variances. In any case, results are wanted on what performance can be expected under conditions of actual usage.

With competent advice or experience, the plant paint engineer can skip the first phases of the test program and go directly to field and service evaluation. This is particularly true in the milder environments. The quality control data can be obtained later by test procedures on those materials which pass the field testing.

Complete records for all phases of the test program are an obvious primary requirement. Yet many test programs are a waste of money because of the absence or incompleteness of records.

Paint testing has been standardized fairly well through the interests of the National, Paint, Varnish & Lacquer Association, The American Society for Testing Materials, and the Federation of Paint & Varnish Production Clubs. Those interested in the composition or properties of paint should have at least two references dealing with this work. The first is *Federal Specification TT-P-141b, Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing,* available from the Superintendent of Documents, Government Printing Office, Washington, D. C. It is an authoritative compilation of all of the physical and chemical testing methods, and includes inspection and sampling procedures, as well as quality control procedure in use by some Federal agencies. The second extremely valuable reference that should be in possession of the reader is *ASTM Standards of Paint, Varnish, Lacquer, and Related Products (with Related Information)*, prepared by Committee D-1 on Paint, Varnish, Lacquer, and Related Products. It may be procured from the American Society for Testing Materials, 916 Race Street, Philadelphia 3, Pa.

The standards of the ASTM are believed to be more detailed and precise and more universal in their application than those of the Federal specification; however, the Federal specification lists many standard tests procedures which have not been adopted by the American Society for Testing Materials. Another extremely valuable reference book which should certainly be in the possession of any paint testing laboratory is the following: *Physical and Chemical Examination of Paints, Varnishes, Lacquers and Colors*, 11th edition, by H. A. Gardner and G. G. Sward. This book is an outstanding treatise upon the testing of paint.

Specific tests to evaluate specific materials and a usable quality control system are presented by J. B. Garner in Volume 1 of the Steel Structures Painting Manual (5).

BIBLIOGRAPHY

1. "Comparative Costs," by L. Adams, Reference 2, Volume 1, Chapter 7.
2. "Steel Structures Painting Manual—Volumes 1 and 2," by J. Bigos, Editor, Steel Structures Painting Council, 1954 and 1955.
3. "Practical Aspects, Use, and Application of Paints," by A. J. Eickhoff and J. Bigos, Reference 2, Volume 1, Chapter 4.
4. "Maintenance Painting of Steel and Coke Oven Plants," by S. C. Frye, Reference 2, Volume 1, Chapter 16, Section II.
5. "Quality Control of Paints," by J. B. Garner, Reference 2, Volume 1, Chapter 6.
6. "Protective and Decorative Coatings, Volume II, Raw Materials—Pigments," by J. J. Matiello, New York, John Wiley and Sons, 1941.
7. "Painting of Water and Sewage Works Structures," by W. T. McClenahan, Reference 2, Volume 1, Chapter 16, Section I.
8. "Directory of Suppliers," Organic Finishing, October, 1955.
9. "Protective Coatings Directory," Chemical Engineering, Vol. 59, No. 12, (1952).
10. R. B. Seymour, Southern Chemical Industry, Vol. VI, No. 1, (1954).
11. "Chemical Resistant Coatings," by R. B. Seymour, Organic Finishing Handbook, Westwood, New Jersey, Finishing Publications, Inc., 1954.
12. "Plastic Equipment Reference Sheets," by R. B. Seymour and R. H. Steiner, Chemical Engineering Progress, Vol. 49, Nos. 4, 6, 7, 8, 9, (1953).
13. "Painting of Chemical Plants," by S. W. Shepard, Reference 2, Volume 1, Chapter 16, Section IV.
14. "Colored Pigments for Protective Coatings Applications," by R. L. Sherman, Organic Finishing Handbook, Westwood, New Jersey, Finishing Publications, Inc., 1954.
15. O. K. Sieplein, Chemical Engineering, Vol. 57, No. 10 (1950).
16. K. Tator, Chemical Engineering, Vol. 59, No. 12, p. 144 (1952).
17. K. Tator, Chemical Engineering Progress, Vol. 51, No. 8, p. 40, No. 9, p. 78, No. 10, p. 64, No. 11, p. 88 (1955).
18. "Polyvinyl Chlor-Acetates," Technical Committee Report 54-4, Corrosion, Vol. 10, No. 10, p. 349 (1954).
19. "Epoxy Resins," Technical Committee Report 56-5, Corrosion, Vol. 12, No. 4, p. 187t (1956).
20. "Chlorinated Rubber Coatings," Technical Committee Report 56-6, Vol. 12, No. 4, p. 191t (1956).
21. "Scientific Paint Evaluation," by E. A. Zahn, Dayton, Research Press Inc. (1955).

PAINTING CODE FOR INDUSTRIAL PLANTS

The following proposed code is offered for consideration as a basic guide. It can be modified to fit the entire industry in a general manner or can be modified extensively to fit special plant needs. Steel Structures Painting Council specifications adequately cover most of the field. They are used in the same manner as ASTM or AISI specifications, by reference, to eliminate needless repetition of detail.

Two primary considerations form the fundamental philosophy behind this code: First, despite the many different steel surfaces to be painted, the great preponderance of steel structures can be adequately painted using a simple, basic system. Secondly, the vast differences in age and condition of plants require consideration since the older plants may not be economical to paint, particularly in corrosive service. The scheme prepared by D. Whitehead for the Crucible Steel Co. is adopted here for designation of class of surface and service. This scheme classifies structures as follows:

Class "A" structures are those modern mill structures where operating conditions are such that it is practical to utilize complete color dynamics and atmosphere is not particularly conducive to inciting corrosion.

Class "B" structures are as above but containing, or are located adjacent to, operations contaminating the atmosphere so as to render it corrosive to metal, or including excessive moisture conditions.

Class "C" structures are those older structures where conditions do not favor the use of full paint color dynamics but where atmosphere is normal.

Class "D" structures are those older structures that because of operating conditions do not lend themselves

Figure 5 — Parts of blast furnace shown here were finish coated with a black alkyd paint.

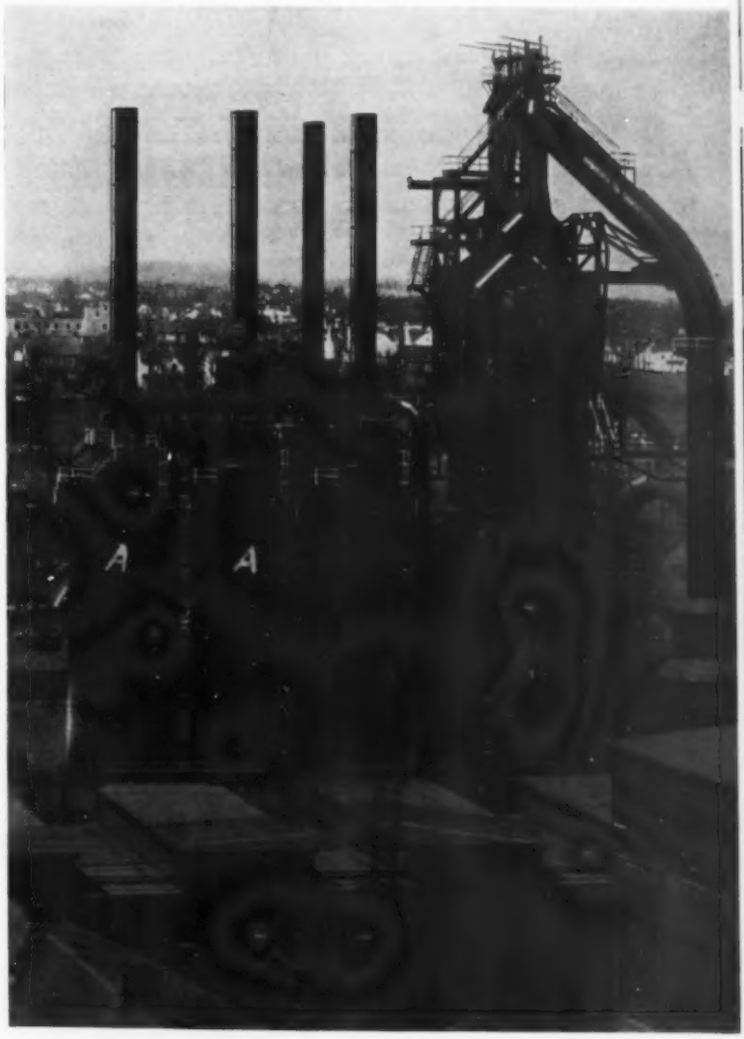


TABLE IV

Class A	Class B	Class C	Class D
Use SSPC-PS 2-55T, "Alkyd Paint Systems (for Weather Exposure, High Humidity, and Infrequent Immersion)." If blast cleaning is unpractical, use SSPC-PS 1-55T, "Oil Base Paint Systems (for Weather Exposure)." See Color Dynamics Finishing.	Use SSPC-PS 4-55T, "Vinyl Paint Systems (for Chemical Exposure, Fresh Water Immersion, Alternate Immersion, High Humidity and Condensation and Weather Exposure)." Or use chlorinated rubber or catalytically cured epoxy systems with proprietary paints, until specification paints are available. Method of surface preparation should be blast cleaning. Lesser methods of cleaning will yield inferior results. For milder service, such as high humidity or condensation without severe chemical contamination, use SSPC-PS 3-55T. See Color Dynamics Finishing.	Use SSPC-PS 1-55T, "Oil Base Paint Systems, (for Weather Exposure)," with hand or power tool cleaning. See Color Dynamics Finishing.	Use SSPC-PS 3-55T," Phenolic Paint Systems (for Fresh Water Immersion, Alternate Immersion, High Humidity and Condensation, and Weather Exposure)," with hand or power tool cleaning where sandblasting is not practical. For badly rusted areas use SSPC-PS 5-55T, "Paint Systems for Hand Cleaned, Water Immersed Steel (for Fresh Water Immersion, Alternate Immersion, High Humidity and Condensation and Weather Exposure)" or SSPC-PS 9-55T, "Bituminous Coatings (Enamel, Cold Applied Mastics and Emulsions)," with hand or power tool cleaning. If exposure is severe, blast clean and use systems listed for Class B or use SSPC-PS 9-55T listed above.

to the application of full paint color dynamics and where in addition atmosphere is corrosion inciting, excessive moisture, or acid flooding conditions exist.

The following code takes into consideration both of the previous factors and outlines suitable painting systems for steel surfaces. In addition, special painting conditions are covered. A description of the complete system and the specifications used follows the recommendations. Note that a surface can fall into more than one group.

Group I. Heavy equipment, steel structures, structural shapes, tanks. Table IV.

Items: Blast furnaces and stoves, annealing furnaces, open hearth furnaces and structures (all with temperatures up to 250 F); steel building walls and frames; cast houses; ore bridges; highway, railroad, and foot bridges; ladders and catwalks; towers; tank exteriors; steam shovels; steam engines; coal bins; railroad cars (standard); boiler houses, boiler stacks up to 250 F; mild areas of coke oven plants; ductwork; gas holders; gratings; guardrails and handrails; derricks, crane runways; and hoist frames; building walls, trusses, columns, downspouts; door and window frames, sash, doors, stairs; galvanized steel; aerial craneways, coal and ore crushers.

Group 2. Machinery, stationary Table V.

Items: air compressors and accumulators; cranes and derricks; pumps; fans and blowers; electric motors and turbines; mill housings, tables and drives; reels; shears; ductwork; blowing room machinery; conveyors; transformer cases and electric control boxes; levellers; fixed welders; polishing lines and rolling mills; stands; safety railings; catwalks, and ladders.

Group 3, Machinery, portable

Items: Diesel and gas engines, cars; caterpillar equipment and cranes; motor equipment; shop cars, straddle buggies, portable welders and compressors; bulldozers; mine locomotives and cars; power shovels; pumping machinery; straddle carriers. Laboratory and office equipment, lockers, filing cabinet, shop tables and benches fall into this category of finishing.

This class of material moves about the plant; it is not necessary to classify it according to the severity of exposure. For practical purposes, one type of finishing is adequate.

Surface preparation should be the best possible; use SSPC-SP 6-55T, "Commercial Blast Cleaning" or SSPC-SP 8-55T, "Pickling," followed by hot phos-

TABLE V

Class A	Class B	Class C	Class D
Use SSPC-PS 2-55T, "Alkyd Paint Systems." Use blast cleaning or pickling followed by hot phosphate or wash primer pretreatment. Otherwise, power tool clean to bare metal before priming. Use glossy medium oil length alkyd finish coats such as Fed. Spec. TT-E-489. See Color Dynamics Finishing.	Use SSPC-PS 4-55T, "Vinyl Paint Systems." Or use chlorinated rubber or catalytically cured epoxy systems with proprietary paints, until specification paints are available. Method of surface preparation should be blast cleaning. Lesser methods of cleaning will yield inferior results. For milder service, such as high humidity or condensation without severe chemical contamination, use SSPC-PS 3-55T. See Color Dynamics Finishing.	Use same surface preparation and paints as for Class A. If not possible, use SSPC-PS 1-55T, "Oil Base Paint Systems," but use medium oil length alkyd topcoats such as Fed. Spec. TT-E-489. See Color Dynamics, Finishing.	Use same surface preparation and paints as for Class B. If not possible, use SSPC-PS 1-55T, "Oil Base Paint Systems" with medium oil alkyd or phenolic topcoats. Chlorinated rubber and epoxy paints specially formulated for this service may be used. Vinyl paints may be used with special primers.

phoric or wash primer pretreatment. Use SSPC-PS 2-55T, "Alkyd Paint Systems" with glossy medium oil length alkyd finish coat such as Fed. Spec. TT-E-489, which is available in a great many colors. It is also possible to use the non-bituminous primer in SSPC-PS 7-55T, "One-Coat Shop Paint Systems for Structural Steel" with alkyd topcoats selected from Paint System 2. In repaint work make extensive use of steam cleaning and power sanding for economical surface preparation.

Group 4. Special conditions.

High-Temperature Painting

Surface Preparation

Up to 250–300 F:

The surface preparation should be adequate for the paint vehicle. Alkyds will often be used and they should be used over clean steel; hot phosphate pretreatment desirable.

250–300 up to 500–600 F:

Blast clean or pickle: hot phosphate pretreatment satisfactory.

Above 500–600 F:

Blast clean—no pretreatment, no rust, dirt, oil or grease tolerable.

Paint

Up to 250–300 F top:

Use PS 2 or PS 3; 2 or 3 coats.

Up to 350–400 F top:

Use Coal tar paints; 2 or 3 coats.

Use TT-E-496. Heat resisting; black 2 or 3 coats.

Up to 450–550 F top:

Special alkyds.

Modified silicones.

Proprietary paints.

Up to 800–900 F top:

Aluminum or zinc dust—silicones.

Zinc dust—silicates.

Butyl titanate paints and proprietary paints.

Decorative Painting of Interiors

Primers in PS 1 are best for heavy, poorly cleaned steel such as building columns and bulkheads, but PS 7 will generally be adequate for most conditions except for highly humid spaces such as laundries, or corrosive spaces such as battery rooms, showers. The disadvantage of PS 1 primers are that they dry too slow and too soft. Primers in PS 2 are excellent for interiors of ships, cargo holds, boiler rooms, offices, shops, etc.; quick drying and dry hard.

Finish paints of a fire retardant value may be advantageous. Those listed here are suitable for interior only.

Finish paints should be of a pleasing and acceptable color, with high reflectivity. See Color in Industrial Plants, Chapter 16, Volume 1.

Low gloss paints of high reflectivity should be used for walls, ceilings, and partitions.

Semi-gloss or gloss paints should be used for trim, dado, etc.

Desks, lockers, cabinets, equipment may be finished in bright color of gloss or semi-gloss, hard alkyd paint by specifying TT-E-489b or TT-E-529.

Use 1 coat primer PS 7 or PS 2; use PS 1 primers on rusty steel but allow to dry hard.

Use 1 or 2 finish coats of paint listed in recommendations. Colors may be standard colors of specification or varied to suit the taste.

Fire Retardant Paints

JAN-P-697 —Light gray, low-gloss, alkyd.
JAN-P-701 —Light green, semi-gloss, alkyd.
JAN-P-702 —White, semi-gloss, alkyd.
Formula 124 —White, semi-gloss, chlorinated rubber alkyd.
MIL-P-17970 —Medical green, semi-gloss, chlorinated rubber alkyd.
MIL-P-17971 —Equipment gray, semi-gloss, chlorinated rubber alkyd.
MIL-P-17972 —Green gray, semi-gloss, chlorinated rubber alkyd.
MIL-P-17973 —Yellow gray, semi-gloss, chlorinated rubber alkyd.
MIL-E-17133A—Cream, gloss, chlorinated rubber alkyd.
MIL-E-17134A—Light gray, gloss, chlorinated rubber alkyd.
MIL-E-17136A—Beach sand, semi-gloss, chlorinated rubber alkyd.
MIL-E-17137A—Red, gloss, chlorinated rubber alkyd.
MIL-E-17138A—Medium blue, gloss, chlorinated rubber alkyd.
MIL-E-17139A—Jade green, gloss, chlorinated rubber alkyd.
MIL-E-17140A—Marine green, semi-gloss, chlorinated rubber alkyd.
MIL-E-17152A—Dark oak, gloss, chlorinated rubber alkyd.
MIL-E-17325 —Rosewood, semi-gloss, chlorinated rubber alkyd.
MIL-E-17326 —Clipper blue, semi-gloss, chlorinated rubber alkyd.
MIL-E-17327 —Light gray, semi-gloss, chlorinated rubber alkyd.
MIL-E-17328 —Cloud gray, semi-gloss, chlorinated rubber alkyd.
MIL-E-17329 —Light blue, semi-gloss, chlorinated rubber alkyd.
MIL-E-17330 —Sea spray blue, semi-gloss, chlorinated rubber alkyd.

Conventional Interior Paints

MAP-48 —White or tints, flat, alkyd and non-penetrating.
52MC-120 —White or tints, flat to eggshell, oleoresinous, linseed oil.
52MC-107 —White or tinted enamel, high gloss, alkyd.
TT-P-51d —Interior wall, white or tints, flat.
TT-E-508 —Interior wall, white or tints, semi-gloss.
TT-E-506b—Interior enamel, white or tints, gloss.

Interior or Exterior, Trim or Equipment Paints

TT-E-529 —16 colors, alkyd, semi-gloss finish paint.
TT-E-489b—36 colors, alkyd, gloss finish.

Above paints may be procured in various shades to match color chips from TT-C-495.

Steel in Contact with Soil

Structural steel that is buried in noncorrosive soils or requires little protection. Examples: Pipelines or structural steel buried in very high resistivity soils, small storage tanks not in contact with cinders, sewage or ground acids, heavy cast iron mains, bottoms of tanks resting on dry soil, sand pads, or concrete.

Use TT-V-51a, asphalt varnish, in SSPC-PS 7-55T "One-Coat Shop Paint Systems for Structural Steel."

Structural steel that is buried in slightly corrosive soils or requires short term or moderate protection. Examples: pipelines or structural steel buried in medium to high resistivity soils, small storage tanks in contact with slightly corrosive soil or backfills.

Use CA-50, coal tar mastic, in SSPC-PS 9-55T "Bituminous Coatings."

Structural steel that is buried in highly corrosive soils, river bottoms, marshland, tidal regions, or which requires very good, long-lasting protection. Examples: pipelines or structurals in low resistivity soils, acid soil or decomposing organic matter, high pressure buried tanks, thin metal, steel partially buried and exposed at ground line.

Use coal tar primer and enamel of SSPC-PS 9-55T "Bituminous Coatings."

Painting of Chemical Areas

Use PS 4 vinyl paints for alcohols such as methyl, ethyl, isopropyl; salts such as chlorides, nitrates, sulphates of ammonia, copper, iron, sodium, potassium, calcium; inorganic acids at low temperatures, low concentrations; caustics and alkaline salts at low temperature; aliphatic solvents and gasoline, fuel oil, sour crude oil; water solutions of most salts. Use Paints 9 and 106 for maximum chemical resistance. Do not use for prolonged direct contact with aromatics or lacquer solvents. Apply sufficient coats to have a minimum of 5 mils dry.

Use PS 3 for mild concentrations of corrosive chemicals such as yards, structural steel, etc.

Use Paint 103, black phenolic, for maximum chemical resistance in milder areas; where appearance is important, use Paint 104 for colored phenolics, or proprietary phenolics formulated especially for chemical resistance.

Use PS 9 for strong concentrations of corrosive chemicals in yards or structural steel in plants. A rust inhibitive primer compatible with the mastic should be used when cold applied mastics are specified. Coal tar enamel and mastic have poor resistance to acids, but good aliphatic resistance; the asphalt mastic has good acid but poor solvent resistance.

Most of the highly resistant materials have poor adhesion to steel or require clean steel surfaces free of rust, millscale, oil, grease or dirt. For paints, the degree of surface preparation that is required varies with the corrosivity. Poor surface preparation in very corrosive

TABLE VI
Specifications for Cleaning and Painting Steel Structures

Specification	Subject	Contents
	Surface Preparation Specifications	
SSPC-SP 1-52T	Solvent cleaning	Covers solvent wiping, immersion, end spraying; vapor degreasing; alkaline, emulsion, and steam cleaning; paint stripping. Removes oil, grease, dirt and soil, salts, and residues of contaminants. Rust and mill scale not removed.
SSPC-SP 2-52T	Hand cleaning	Covers hand chipping, scraping, sanding, and wirebrushing. Removes loose rust, loose mill scale, and loose paint to degree specified.
SSPC-SP 3-52T	Power tool cleaning	Covers power tool chipping, descaling, sanding, wirebrushing, and grinding. Removes loose rust, loose mill scale, and loose paint to degree specified.
SSPC-SP 4-52T	Flame cleaning of new steel	Covers flame dehydrating and cleaning followed by wirebrushing. Removes rust, loose mill scale, and some tight mill scale.
SSPC-SP 5-52T	Blast cleaning to "white" metal	Covers nozzle (dry, wet, or vapor) or centrifugal blast cleaning using sand, synthetic abrasives, crushed iron or steel grit and shot. Completely removes all rust, mill scale, paint, and foreign matter.
SSPC-SP 6-52T	Commercial blast cleaning	Covers above blast cleaning but removes rust and mill scale only to degree specified. Slight residues of tight rust and mill scale remaining are generally tolerable.
SSPC-SP 7-52T	Brush-off blast cleaning	Covers above blast cleaning but removes considerably less rust and mill scale. Considerable residues of tight rust and mill scale are generally tolerable for less severe exposures particularly with good wetting primers.
SSPC-SP 8-52T	Pickling	Covers sulphuric, hydrochloric, and phosphoric acid pickling; duplex pickling and electrolytic pickling. Completely removes rust and mill scale; some operations passivate the surface.
SSPC-SP 9-52T	Weathering	Covers exposure to weather to remove mill scale by rusting. Leaves considerable rust and residue of mill scale. Must be followed by other cleaning methods. Commercial blast cleaning recommended.
	Pretreatment Specifications	
SSPC-PT 1-53T	Wetting oil treatment	Covers application of wetting oils to surfaces, from which all rust and mill scale have not been removed, to improve adhesion and bond of paint.
SSPC-PT 2-53T	Cold phosphate surface treatment	Covers application of phosphoric acid treatments to passivate steel surfaces which have been thoroughly cleaned.
SSPC-PT 3-53T	Basic zinc chromate vinyl butyral washcoat	Covers application of wash primer to thoroughly cleaned steel; improves adhesion and bond of paint; reduces underfilm corrosion.
SSPC-PT 4-53T	Hot phosphate surface conversion	Covers hot conversion by zinc or iron phosphate solutions to form crystalline surface for improvement of paint bonding and reducing of underfilm corrosion.
	Paint Application Specifications	
SSPC-PA 1-53T	Shop, field, and maintenance painting	Completely covers all phases of paint storage, mixing, thinning, application by brush or spray in shop or field, permissible temperatures and humidities, drying, and protection of painted steel.

circumstances almost invariably leads to short protective life.

Steam cleaning may be used to great advantage to remove soluble corrosive salts, oil, grease, dirt, soil, etc., from the surface.

Blast cleaning to white metal is almost mandatory to obtain long service life in the extremely corrosive exposures.

In yard areas, or interiors exposed only to low concentration of fumes or gases, hand or power tool cleaning may suffice.

Extremely corrosive conditions, such as complete immersion in strong acids, require linings. These may be natural or synthetic rubber, baked or catalytically cured phenolics, furanes or epoxys; these may be applied as cements or sheet linings. Grease or wax type rust preventive compounds are often used where they can be easily replaced as necessary.

The vinyl paints are widely used for resistance to chemicals. They are quite inert and unaffected except, primarily, to strong oxidizing agents or powerful solvents such as aromatics and ketones. They have a low upper limit of temperature. For complete immersion, they may be applied in numerous coats to a thickness approaching linings. Obviously, the pigments must be chosen so that they do not react with the chemical. Aluminum is no good in contact with alkalies. Carbon black or titanium dioxide pigmented vinyls have good chemical resistance. Red lead has fairly good chemical resistance when used in the underlying coats.

Under highly acid conditions, zinc chromate should not be used. Completely inert pigmented paints should be used for all coats.

Coal tar enamel and coal tar and asphalt mastics have good chemical resistance and are used extensively for structural steelwork or exteriors of equipment.

Chlorinated rubber, neoprene, vinylidene chloride, styrene butadiene copolymer, and epoxys have good resistance and may be procured as proprietary paints.

Paint System No. 1, Oil-Base Paint Systems

(For Weather Exposure)

Paint System No. 1 requires good cleaning: minimum surface preparation is hand or power tool cleaning per SSPC specifications. Four standard heavy duty primers are included: SSPC-Paint 1-55T (red lead-raw linseed oil); Federal Specification TT-P-86a. Type I (red lead-raw and bodied linseed oils); SSPC-Paint 2-55T (75 per cent red lead/25 per cent iron oxide-2 linseed oil/1 alkyd); SSPC-Paint 3-55T (75 per cent red lead/25 per cent iron oxide-fractionated linseed oil). Alternate primers are: TT-P-64lb, Type I (zinc dust-zinc oxide-raw linseed oil)—good for galvanizing; SSPC-Paint 4-55T (extended red lead-linseed oil); Federal Specification TT-P-57, Type I (zinc chromate-yellow iron oxide-linseed oil-alkyd); SSPC-Paint 11-55T (same as TT-P-57, Type I, but red color); Federal Specification TT-P-86a, Type II (extended red lead-iron oxide-linseed oil-alkyd); AASHO-M72-51, Type IV (red lead-linseed oil-alkyd). The standard system consists of two coats of primer and a finish coat of aluminum, but numerous alternate oil, alkyd, and phenolic intermediate and finish paints are included.

Paint System No. 2, Alkyd Paint Systems

(For Weather Exposure, High Humidity, and Infrequent Immersion)

Paint System No. 2 requires particularly good cleaning. Commercial blast cleaning or pickling is standard, due to limited wetting of primers; but alternative methods of surface preparation also may be specified. Standard primers are: Federal Specification TT-P-86a, Type III (red lead-alkyd); Federal Specification TT-P-57, Type II (yellow iron oxide-zinc chromate-alkyd); Military Specification JAN-P-735 or Maritime Administration 52-MA-202 (zinc chromate-titanium dioxide-alkyd); Military Specification MII-P-17545 or Maritime Administration 52-MA-201a (red lead-zinc chromate-extenders-alkyd). A zinc dust primer alternate excellent for new galvanizing is Federal Specification TT-P-641b, Type II. Alkyd intermediate and finish paints are listed. They include bright colored glossy, semigloss, or lustreless finishes for equipment, machinery, trim, walls, etc.

Paint System No. 3, Phenolic Paint Systems

(For Fresh Water Immersion, Alternate Immersion, High Humidity and Condensation, and Weather Exposure)

Paint System No. 3 has the same standard surface preparation requirements as PS 2. Phenolic paints are used for resistance to water. Standard primers include: Federal Specification TT-P-86a, Type IX (extended red lead-phenolic); SSPC-Paint 5-55T (zinc dust-zinc oxide-phenolic); Federal Specification TT-P-57, Type III (red iron oxide-zinc chromate-phenolic); SSPC-Paint 6-55T (red lead-iron oxide-phenolic); SSPC-Paint 10-55T (iron oxide-zinc chromate-red lead-extender-phenolic). The first two primers are excellent for potable water. SSPC-Paint 7-55T is an economical dust-iron oxide alternate primer. Aluminum phenolic is the standard finish, but phenolic finish alternates are included. In fact three or four coats of primer often constitute the entire underwater system. Oil or alkyd topcoats in PS 1 or 2 may be used for structures above water or exteriors.

Paint System No. 4, Vinyl Paint Systems

(For Chemical Exposure, Fresh and Salt Water Immersion, Alternate Immersion, High Humidity and Condensation, and Weather Exposure)

Paint System No. 4 is highly resistant to most chemicals and water. The standard system requires commercial blast cleaning or pickling, and wash primer pretreatment of the surface. The standard primer is Military Specification MIL-P-15929A (red lead vinyl paint). This paint will not adhere to bare steel. Alternate vinyl primers are: MIL-P-15930A (zinc chromate); SSPC-Paint 8-55T (aluminum for water or atmosphere); SSPC-Paint 9-55T (titanium dioxide pigments for maximum chemical resistance). Vinyl and viny alkyd alternate primers in various colors are included. The standard system calls for aluminum vinyl finish paints. Vinyl alkyd finishes brush better, but have less chemical resistance. SSPC vinyl paints may be used over bare steel, wash primer, or other vinyl resin paints.

TABLE VII
Finish Paints

SSPC Paint 101-55T, "Aluminum Alkyd Paint."	An aluminum alkyd paint mixed-on-the-job by adding two pounds of aluminum paste to one gallon of alkyd varnish vehicle; highly resistant to atmospheric exposures.
AASHO Specification, "Aluminum Paint," Designation M-69-52.	AASHO ready-to-mix aluminum finish coat for bridges.
Aluminum Phenolic Paint as follows: Two pounds of aluminum paste, as specified in f(1) shall be mixed on the job with one gallon of phenolic varnish conforming to Federal Specification TT-V-119, "Varnish, Spar, Phenolic-Resin." (Copy specification for pigment or else substitute phenolic varnish requirements for mixing varnish on left).	An aluminum phenolic paint mixed on the job by adding two pounds of aluminum paste to one gallon of phenolic varnish; highly resistant to water immersion, high humidity, condensation, general atmospheric exposure, and mild chemical environments, but should not be used in strongly alkaline environments. If ready-mixed aluminum phenolic is desired, specify paint as in f(2).
AASHO Specification "Black Bridge Paint," Designation M68-52.	AASHO carbon black, metallic oxides, linseed oil finish paint for bridges; high durability in atmospheric exposure.
Federal Specification TT-P-27, "Paint, Graphite, Outside, Ready Mixed." Type I or II may be used. (But if a natural crystalline flake Graphite is desired, Type I should be specified.)	A black graphite and linseed oil paint with very high durability in atmospheric exposure. Type I is a natural crystalline flake graphite while Type II contains amorphous graphite; particularly useful under very adverse conditions such as heavy industrial areas or railroad bridges where oil base paint is desired.
Federal Specification TT-P-61b, "Paint, Ready Mixed Black."	A carbon black metallic oxide and linseed oil paint that has high durability and provides excellent service in severe environments such as the preceding.
SSPC-Paint 102-55T, "Black Alkyd Paint."	A very durable carbon black and long oil alkyd varnish paint which is recommended for severe exposures such as railroad bridges and industrial atmospheres.
SSPC-Paint 103-55T, "Black Phenolic Paint."	A carbon black and silica phenolic varnish paint which is suitable for water immersion, high humidity, condensation, or in industrial atmospheres, or in chemical environments.
Federal Specification TT-P-20, "Blue Lead Paint." If a darker color is desired, it shall be tinted to a shade agreed upon between the parties concerned.	A blue lead and linseed oil paint, gray in color and used as a chalking gray finish coat for atmospheric exposure. The color may be tinted to a darker shade if desired.
SSPC-Paint 104-55T, "White or Tinted Alkyd Paint," Type II, "medium or Light Gray." The shade shall be agreed upon between the parties concerned.	A gray, long oil alkyd paint that has high resistance to industrial atmospheres. The paint may be tinted to shades varying from light to medium gray.
SSPC-Paint 105-55T, "White or Tinted Phenolic Paint," Type II, "Medium or Light Gray." The shade shall be agreed upon between the parties concerned.	A gray phenolic paint which is relatively inert and has good resistance to water immersion, high humidity, condensation, atmospheric exposure, and chemical environments. It may be tinted to shades varying from light to medium gray.
Federal Specification TT-P-71b, "Paint, Ready Mixed, Exterior, Chrome Green."	A green linseed oil-varnish exterior paint that has good durability to atmospheric exposure; but due to the chrome green pigment, fading and loss of color may result. Not recommended for chemical environments.
AASHO Specification "Foliage Green Bridge Paint," Designation M67-52, Type I shall be specified for white lead base, Type II for white lead and zinc oxide base.	Green chrome oxide-linseed oil paint; white lead, or white lead and zinc oxide bases available. Very good durability in atmospheric exposure, although some slight loss in color may occur.
SSPC-Paint 104-55T, "White or Tinted Alkyd Paint," Type III, "Light Green or Gray-Green." The shade shall be agreed upon between parties concerned.	This alternate covers a range in color from light green to gray-green. The vehicle is a long oil alkyd varnish; has good resistance to atmospheric exposure, particularly industrial atmospheres.
SSPC-Paint 104-55T, "White or Tinted Alkyd Paint," Type IV, "Dark Green." The shade shall be agreed upon between the parties concerned.	Similar to the preceding. However, the pigment is a chrome green which will be durable in atmospheric exposure, but some loss in color may occur.
SSPC-Paint 105-55T, "White or Tinted Phenolic Paint," Type III, "Light Green or Gray Green."	A range in color from light green to gray-green in a phenolic varnish paint; recommended for water immersion, atmospheric exposure, high humidity, condensation, or mild chemical environments.
SSPC-Paint 105-55T, "White or Tinted Phenolic Paint," Type IV, "Dark Green." The shade shall be agreed upon between the parties concerned.	A chrome green phenolic paint good for water immersion, or atmospheric exposures.
Federal Specification TT-P-31b, Paint "Iron Oxide, Ready-Mixed, Red and Brown." The color shall be agreed upon between the parties concerned.	Iron oxide paint with an oil base; may be obtained in shades ranging from red to brown; extremely durable in atmospheric exposure although the colors are dark.
AASHO Specification "White and Tinted Ready-Mixed Paint," Designation M70-52. One of the following shall be specified: Type I Class A-White, general purposes; Type I Class B-Tint-base; Type I Class C-White, special fumeproof (lead base); Type II White lead base.	The AASHO white or tint base paints for highway bridges; may be tinted to light shades if desired. The color should be specified, as well as the type.
Federal Specification TT-P-102, "Paint (Titanium-Lead-Zinc and Oil, Exterior, Ready-Mixed, White and Light Tints)." If a chalking white is desired, Class A shall be specified; if a non-chalking white or light tint is desired, Class B shall be specified and the color shall be agreed upon between the parties concerned.	White oil paint containing a mixture of titanium, lead and zinc pigments. Two types are available, chalking and nonchalking. If the paint is to be tinted, the non-chalking type should be specified.
Federal Specification TT-P-103, "Paint (Titanium-Zinc and Oil, Exterior, Fume Resistant, Ready-Mixed, White)."	White oil paint which is recommended for industrial areas where lead base paints may turn black.
Federal Specification TT-P-104, "Paint (White Lead and Oil, Exterior, Ready-Mixed, White and Light Tints)." If a color other than white is desired the color shall be agreed upon between the parties concerned.	White lead oil base paints for exterior use; may be tinted as desired.
SSPC-Paint 104-55T, "White or Tinted Alkyd Paint," Type I, "White."	A white, long oil alkyd finish paint containing an inert pigment; recommended for industrial exposure; slight chalking.
SSPC-Paint 105-55T, "White or Tinted Phenolic Paint," Type I, "White."	A white phenolic paint for atmospheric exposure, water immersion, high humidity, condensation, or mild chemical environments. The white obtained may be slightly off-color due to the phenolic varnish; color stability may be poor.
Federal Specification TT-E-489b, Class A, "Enamel, Gloss, Synthetic." The color desired shall be specified.	A series of medium oil, alkyd colored enamels, suitable for interior or exterior use; high gloss but low build per coat; particularly suited for machinery and similar equipment where appearance is important.
Federal Specification TT-E-529, Class A, "Enamel, Synthetic, Semi-Gloss." The color desired shall be specified.	Similar to preceding but semi-gloss.
Federal Specification TT-E-527, "Enamel, Synthetic, Lustreless."	Similar to preceding two paints but flat finish.

Paint System No. 9, Bituminous Coatings

(Enamel, Cold Applied Mastics, and Emulsions)

Paint System No. 9 requires commercial blast cleaning or pickling in the standard system. One thick coat of cold-applied asphalt mastic (SSPC-Paint 12-55T) is the standard bituminous coating. This may be applied in two coats when specified. This standard mastic is suitable for chemical, atmospheric exposure, but not underground. Similar systems are included as alternates using coal tar mastics, asphalt emulsion, and coal tar emulsions. These latter materials generally are applied in at least two coats, with coal tar mastic giving best results. Coal tar emulsion is used to protect coal tar cutbacks or enamels from sunlight. Coal tar primers and enamel are included as alternates in this system. AWWA C203-51 is used for fresh water immersion (including potable) and underground use, while Bureau of Yards and Docks 34Yb coal tar primer and enamel is used for marine structures.

Color Dynamics Finishing

Color makes plants attractive in appearance, but its effects are more far reaching than that. True color dynamics or color finishing uses functional aspects of color. By using light colored paints with high reflectivity, visibility is increased. Elimination of excessive contrast between dark and light areas and the elimination of glare reduces workers' eye fatigue. Proper color improves safe working conditions. Proper color increases worker output by concentrating attention to work areas. Output is also increased because of the pyschological effect of attractive working conditions, cleaner rest rooms, and dressing rooms, more pleasant meals in friendly cafeterias, etc. Plant housekeeping is made easier by color conditioning. Finally, color is of great value for safety purposes and identification of pipelines.

Reflectivity is a measure of the total amount of light reflected from a surface compared to the amount incident to the surface. Gloss refers to the luster or shininess of a surface. The angle of incidence and the angle of viewing greatly affect the apparent gloss of a surface. Light reflectiveness and gloss are independent of one another. White is high in reflectance and black is low. Paints are classified for glossiness as glossy, semi-gloss, and flat. The washability of a paint is usually better the higher the gloss. Weatherability of high gloss paints is usually poorer than the semi-gloss or flat paints.

Most industrial paints come in semi-gloss to flat. These are satisfactory for most uses. For machinery, trim, portable equipment, etc., glossy finishes are usually desired. These are procurable in enamels such as the medium oil length alkyds represented by Federal Specification TT-E-489 in 21 colors. If semi-gloss or flat enamel finishes are desired, those can be procured under Federal Specifications TT-E-529 or TT-P-527 respectively. Note that these enamels come in air dry and baking finishes and the proper one must be specified.

Consider now the painting of an industrial plant for good appearance. The specific colors chosen can be supplied in paints that will provide protection to the substrate.

The heavy duty finish paints in Paint System No. I, "Oil Base Paint Systems (For Weather Exposure)" are shown in Table VII. These paints may be used for Class A or Class C surfaces.

All of the preceding paints may be used in Paint System No. 2, "Alkyd Paint Systems (For Weather Exposure, High Humidity, and Infrequent Immersion)," but generally only the alkyd finish paints would be used because the primers are alkyds. Linseed oil finishes are soft, dry slowly, and pick up dirt. Despite this protective ability, they would probably be limited to Class C paints. The phenolic finish paints may be used for Class B or Class D structures over thoroughly dry linseed oil, alkyd or phenolic primers where corrosive conditions are only moderately so. The specifications permit the alternate color to be specified by the purchaser.

For extremely corrosive conditions, vinyl, chlorinated rubber, or catalytically cured epoxy paints may be used in most colors. SSPC-Paint 9-55T, "White (Or Gray) Vinyl Paint" may be procured in almost any

TABLE VIII

National Safety Council Pipe Line Color Codes

	Color—Federal Spec.	Transfer decal
Water—sprinkler, plug	Red—TT-C-595-1110	Fire
Foamite	Red—TT-C-595-1110	Foamite
Steam, quenching	Red—TT-C-595-1110	Q steam
Acetylene	Yellow—TT-C-595-1320	Acetylene
Ammonia	Yellow—TT-C-595-1320	Ammonia
Gas—annealing atmosphere	Yellow—TT-C-595-1320	A.A. gas
Gas—coke oven	Yellow—TT-C-595-1320	C.O. gas
Gas—blast furnace	Yellow—TT-C-595-1320	B.F. gas
Gas—exhaust	Yellow—TT-C-595-1320	Ex. gas
Gas—hydrogen	Yellow—TT-C-595-1320	Hydrogen
Gas—mixed	Yellow—TT-C-595-1320	Mix gas
Gas—natural	Yellow—TT-C-595-1320	Nat. gas
Gasoline	Yellow—TT-C-595-1320	Gasoline
Kerosene	Yellow—TT-C-595-1320	Kerosene
Acid waste	Yellow—TT-C-595-1320	W. acid
Acid	Yellow—TT-C-595-1320	Acid
Gas—CO_2	Orange—TT-C-595-1210	CO_2
Gas—Oxygen high purity 99	Orange—TT-C-595-1210	Oxy. 99
Gas—Oxygen low purity 95	Orange—TT-C-595-1210	Oxy. 95
Oil—coolant	Orange—TT-C-595-1210	Coolant
Oil—fuel	Orange—TT-C-595-1210	Fuel oil
Oil—hydraulic	Orange—TT-C-595-1210	Oil hydr.
Oil—lubricating	Orange—TT-C-595-1210	Oil lube
Water—high pressure	Orange—TT-C-595-1210	W.H.P.
Air—low pressure	Green—TT-C-595-1475	L.P. air
Air—compressed	Green—TT-C-595-1475	C. air
Drains	Green—TT-C-595-1475	Drain
M.E.A. solution	Green—TT-C-595-1475	M.E.A.
Prestone	Green—TT-C-595-1475	Prestone
Water—raw service	Green—TT-C-595-1475	R.W.
Water—clear service	Green—TT-C-595-1475	C.W.
Showers—acid area	Blue—TT-C-595-1520	Showers
Water—drinking, etc.	Blue—TT-C-595-1520	D.W.
Steam—high pressure	Yellow—TT-C-595-1320	H.P. steam
Steam—low pressure	Orange—TT-C-595-1210	L.P. steam
Steam—exhaust	Green—TT-C-595-1475	Ex. steam
Electric	Stencil voltage	110V
Electric	Stencil voltage	220V
Electric	Stencil voltage	440V
Electric	Stencil voltage	2300V
Electric	Stencil voltage	250DC
Electric	Stencil phone	Phone
Vacuum conveyor		Vac.
Dust conveyor		Dust
Water drain		W. drain

color. Proprietary epoxy and chlorinated rubber paints are available in color.

The specific color of paint that is desired can be specified by using the federal color manual. Federal Specification TT-C-595, "Colors (for Ready-Mixed Paints)." It contains a satisfactory range of colors for normal use.

Suggested color schemes and more information on color are found in the reference by Shepard (13).

The National Safety Council and the American Standards Association have been active in promulgating codes for safety and identification based upon color. Table VIII shows the color code worked out by the Crucible Steel Co. using the safety color codes. Transfer decals for pipe legends have been found better than painting the legends on the pipes.

DISCUSSION

PRESENTED BY

C. R. SCHOFIELD, Director of Laboratories, Process and Product Development Div., Republic Steel Corp., Cleveland, Ohio

BEN HOLLIDAY, Chemist, Materials Engineering Div., Crucible Steel Co. of America, Midland, Pa.

JOSEPH BIGOS, Senior Fellow, Mellon Institute and Director of Research, Steel Structures Painting Council, Pittsburgh, Pa.

JAMES W. LOWRY, Purchasing Agent — Mill Supplies, Republic Steel Corp., Cleveland, Ohio

J. D. BROWN, Lubrication Engineer, Jones & Laughlin Steel Corp., Cleveland, Ohio

CHARLES T. LEWIS, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

C. R. Schofield: In general, we agree wholeheartedly with the statements as put forth in the paper. Of noteworthy importance, is the emphasis on base metal preparation before the application of any protective coating. The ultimate performance of a coating system can be no better than the condition of the base surface to which it is applied.

Longevity in coating life, is not always dependent on the paint cost factor, but is largely dependent on base preparation, the selection of the right primer and subsequent finish coats for the particular requirements involved.

We agree, that complete records should be kept outlining the conditions existing at the time of applying a coating system, if a sound evaluation is to be made for future reference.

Conditions being unpredictable as to the time interval between shop priming of structural members and field coating, as well as atmosphere and storage conditions during that time, we feel that a primer, whether it be a shop coat or field coat should have the same resistance to weathering.

So far, in our experience, accelerated tests conducted in the laboratory in conjunction with outdoor exposure tests show immense value in predetermining the expected performance of a given coating or coating system.

On the basis of limited tests of maintenance paints, indications are, to date, that the salt spray test more closely approaches the actual breakdown which occurs on outdoor exposure in the average industrial area, then any other single accelerated test.

The purchase of paint, should definitely be bought on some type of a specification basis. Detailed paint formula specifications, outlining exact percentages of each ingredient, are all right if a company is interested in the making of paint, or will stand the expenditure of establishing a department, staffed by competent paint chemists and formulators.

Our preference is a performance specification which permits us to avail ourselves of the vast amount of paint technology and knowhow in the paint and coatings industry to accomplish this work for us. By furnishing a performance specification, based on accumulated test data of present coatings, or a complete analysis of the problem at hand, the paint chemist has a definite point from which to start formulating.

Dealing only with reputable coating suppliers, we place the sole responsibility for the performance and quality of the product where it rightfully belongs.

Color dynamics has not as yet made too much headway in the steel industry as a whole, although there is much merit to systems of this kind.

Standardization of colors in the steel industry, using the Federal Color Standards Manual also has merit and is now being practiced by us, wherever possible, in establishing maintenance paint color systems.

Regardless of what route we take, we all have one goal in mind, "The best possible coating with the longest life" "at the lowest practical cost."

Ben Holliday: One question I would like to ask concerns the use of metallizing. Has any comparison been made of the metallizing process, when used to protect new steel equipment against the repeated painting of steel?

Another question which entered my mind was the color for painting storage tanks, such as are used in a coke plant for benzene, light oil, and other volatile products. What is the difference in evaporation rate between a black or gray color in comparison with a white or luminous finish?

Joseph Bigos: In regard to the subject of metallizing, there are places for metallizing, but its use is not universal. There is no universal answer to the coating system, and any coating is a compromise. There is no question that metallizing is a good substitute for painting. However, metallizing is very expensive, because it requires blast cleaning to white metal, requires deposition of a coat of metallic aluminum or zinc by spray, and it requires sealing by paint to protect the metallizing. Otherwise the metallizing will fail very shortly in ordinary exposure. Even considering all of this, there are cases where it appears to be an economical protective coating system—again I emphasize that in some circumstances—in spite of the metallizing cost which is about $1.50 a sq ft, plus the painting, it possibly is justified.

However, I feel that hot dip galvanizing is a better answer where it is necessary to have something to get corrosion protection besides paint. Where hot dip galvanizing can be done, it is economical. In fact, cost analyses indicate that hot dip galvanizing is more economical than painting under certain circumstances,

such as in the atmospheres where the life of the galvanizing is long.

In regard to the other question, the painting of high volatile solvent storage tanks in a coke plant, ordinarily is not much of a problem. There is no question that painting a tank will cut down the surface temperature and reduce losses of volatile solvent. Whether a tank roof can be kept white in a coke plant is questionable.

I would like to point out that most people paint the roof white to cut the temperature down considerably, and it will. The greatest saving accrues by painting the sides white, rather than the roof.

Painting tanks white will cut the evaporation losses down and in typical cases as much as 25 per cent of evaporation loss compared to the loss of the tank which is painted black. It is quite possible to have a saving as high as $10,000 a year in a single tank.

Aluminum is not as good as white paint for this purpose. Aluminum is about 75 per cent efficient, or a little less, perhaps 50 or 75 per cent efficient, as compared with white for reducing losses due to evaporation. However aluminum has an advantage, that you get better paint life than with white paint. White paint, to be effective in this process, must be a chalking white. If it is chalk white, its life is very limited, probably about four years for a single coat, whereas the aluminum coat will probably give six or seven years in the same environment. Therefore, we have another factor to consider. We must take into account the increased painting cost in using the white in place of the aluminum. Economics generally favor white paint rather than aluminum, even taking into account the extra number of repaints.

When you talk about a coke plant, I begin to wonder. I do not have the experience with white in a coke plant to give you the answer. I strongly suspect it is hard to keep paint white in a coke plant. Any coke plant I have been in was black and dirty, but if you can keep it white, a good white paint will reduce the storage loss.

James W. Lowry: In regard to the use of aluminum paint where there are volatile materials present, it has been our experience that sparking is a problem. When aluminum paint has been put over any rust it is apt to spark when struck by a piece of metal even though it may be a well known non-sparking tool.

What is your opinion?

Joseph Bigos: There is no question about the fact that aluminum in the form of a fine powder used as a pigment in paint when in contact with rust under the proper conditions will spark. I would say that it would almost have to be a warm surface since a cold surface will not permit a spark. If aluminum paint is used on a rusty steam line of 212 or 250 F and if struck with a steel tool or any other tool it may spark. If, however, a primer, which is generally the proper thing to use, is present under the top coat of aluminum, you do not get that effect. There is no known case of an explosion caused by this phenomena.

J. D. Brown: We have had come to our attention primer products which are quick-drying, drying within 10 to 15 minutes after being applied. Of course, there is a saving in putting the finish coat of paint on. I was wondering if the author had had any experience with accelerated tests with these quick-drying primers on precleaned steel and what it may be.

Joseph Bigos: Over a clean steel you can put a wash primer which is a pretreatment, and it will dry within 30 minutes. It is very good for painting.

We have not worked with any such primers which are bona fide primers—that is, they do not violate any of the rules and conditions of the field. There ought to be primers which will dry in 10 to 15 minutes, which can be used on blast cleaned steel. That is purely a question of solvents, where the vehicle is a synthetic resin or lacquer type of material. How fast you get the solvent out from the film is purely a question of working out the drying time versus the safety hazards and so on.

There are a number of these primers that you have mentioned, which are highly advertised to be used over rusty steel. We have worked with some of those. I can say we never yet found a primer that was advertised as satisfactory to use over rusty steel that was any particular good over rusty steel.

Charles T. Lewis: In illustrating the scratch tests on painted panels, the top row being hot dip, the bottom being electro-galvanized, and to the extreme I recall both were phosphate treated. It appeared as though the electro-galvanized was less susceptible to failure than the hot dip. Am I correct in that?

Joseph Bigos: I do not believe so. There is no apparent difference in protection afforded by hot dipping, electric deposition, or metallizing provided the weight of coating is the same.

WANTED!

There is constant demand for copies of "The Modern Strip Mill," published by the Association of Iron and Steel Engineers. If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Pictorial Roundup

AISE Western Meeting

San Francisco, Calif.

March 4, 5, 6, 1957

Some 475 men registered (1) at the fourth annual Western Meeting of which 95 came from east of the Mississippi. Local officers and AISE secretaries get together at a dinner meeting (2) to discuss Western Sections affairs. Authors and chairmen of the various sessions get together at a breakfast meeting to plan the day's activities. Shown in (3) are W. T. Purvance, Columbia-Geneva Div., U. S. Steel; Donald E. Cummings, Air Products, Inc.; M. A. Fay, General Refractories Co.; G. W. Teskey, Jr., Bethlehem Pacific Coast Steel Corp.; and E. S. Harman, E. S. Harman Corp. In (4) are seen A. E. Cichelli, Bethlehem Steel Co.; E. C. Thomas, Pacific States Steel Corp.; H. J. Kalberkamp, Mesta Machine Co.; H. I. Riegel, Kaiser Steel Corp.; and Kurt Schlesinger, United Engineering and Foundry Co. In (5) are seen standing: J. Wm. DePoy, The Colorado Fuel & Iron Corp.; Robert B. Stewart, Dow-Corning Corp.; sitting are William Brill, The Colorado Fuel and Iron Corp.; and Harold G. Degitz, Columbia-Geneva Div., U. S. Steel Corp. The program for the fourth session was in the hands of (6) E. F. Donatic, Kaiser Steel Corp.; Maurice A. Nye, Vaughn Machinery Co.; F. Nolan, Allis-Chalmers Manufacturing Co.; C. C. Brandt, Bethlehem Pacific Coast Steel Corp.; and sitting, D. Lawrence Pierce, Westinghouse Electric Corp. and R. C. Suttle, Reliance Electric and Engineering Co.

Five AISE secretaries were present (7) and clustered around Jim McCormick, secretary of the host San Francisco section, can be seen Phil Ashurst, from Detroit; Jim Kinney, from Los Angeles; R. T. Blakley, from Salt Lake City; and Bob DuBois, from Chicago. In (8), E. S. Harman is pointing out some of the highlights during a movie. H. I. Riegel discusses water problems in (9), and Harold G. Degitz is covering the expansion done by Columbia-Geneva in (10). Attendance at sessions was excellent (11).

Jim O'Roark is reporting on the status of the AISE at the informal stag dinner (12). In (13) can be seen the speakers' table, and in the usual order are E. C. Thomas, San Francisco chairman; William Perry, past president AISE; L. J. Westhaver, executive vice president, Columbia-Geneva Div. U. S. Steel Corp.; W. J. McClung, vice president (steel plants), Bethlehem Pacific Coast Steel Corp.; J. D. O'Roark, president AISE, Joseph Eastwood, Jr., president, Pacific States Steel Corp.; Charles H. Williams, past president AISE; William Marshall, past chairman San Francisco section; and T. J. Ess, managing director AISE.

The informal stag dinner was well attended with 419 present (14). Top management representation at the meeting included W. J. McClung, L. J. Westhaver, and Joseph Eastwood, Jr. (15). In (16) two past presidents, Charles Williams and William Perry, are congratulating Jim O'Roark in the center on the success of the meeting. Some 100 members made the inspection trip (17) to the San Francisco plant of the Bethlehem Pacific Coast Steel Corp.

7

8

9

10

11

12

13

14

15

16

17

By DR. R. P. PETERSEN, Director Nuclear Research,* Republic Steel Corp., Cleveland, Ohio

NUCLEAR TECHNOLOGY AND

▲THE steel industry is a prolific user of fuels; the requirement for thermal units amounting to well over the equivalent of a ton of coal per ton of product. This is over and above the carbon needed for chemical reactions. Very understandably, the industry has been marked by its deference to production goals, and only recently has the necessary use of lower grade deposits of ore, the spectre of coking coals of higher sulphur content, and above all the problems of high capital costs for expansion suggested that alternate methodology may be making its appearance in the years immediately ahead. This is as it should be, for the difference between science and technology is the addition of an economic incentive. What is to be emphasized is that with increased manpower costs, and violently increased capital costs, there are greater incentives than ever before for reviewing all the steelmaking processes for higher rates and efficiencies as well as for alternates.

Among the new technologies, nuclear energy and its associated effects—gamma radiation and neutrons—seems destined to play an important role. It is the purpose of this paper to give a brief review first of the significance of atomic energy and then of some of the other interests which exist.

There have been so many estimates of the future of nuclear technology from all sorts of aspects, that in this paper we do not wish to defend in detail our own estimate of atomic power costs. Time, in any case, is the only validator. It does seem that the rate of progress illustrated in Figure 1 cannot be ignored. The fact of the matter is that assuming successful technology in this new field, nuclear power ought to be cheap—10 cents per million Btu; transportable—the fuel cost will be independent of location, and at some later date obtainable at high temperatures. The temperature of an uncontrolled reactor is several million degrees, and fission temperatures must be quickly degraded to retain a reactor structure.

That the potential of 10 cents per million Btu exists can be understood by considering the costs of placing a pound of uranium metal in a reactor and the energy obtainable from it. U_3O_8 is worth about $7.00 per lb and obtaining the metal from the oxide might add $13.00. Conversion to a fuel element taken at $10 per lb would result in a total cost of $30.00 per lb of uranium placed in a reactor. Assuming 1 per cent of this uranium could be burnt before having to replace the fuel element, we would get 4.54 grams of uranium fissioned, yielding a total of 3×10^8 Btu from the $30.00 worth of fuel element. Thus we have 300,000,000 Btu for 3000 cents or 10 cents per million Btu even without taking credit for the spent fuel.

The reactor will have to incorporate biological shields, instrumentation, fuel handling facilities, and controls. These items represent a fixed capital, nearly independent of reactor power level. For this reason, it is desirable to have reactors as large as possible. However, reactors as small as 50 megawatts of heat will probably be competitive. $50 per thermal kw capacity is a reasonable figure to use for a process heat plant.

From the standpoint of steel, you might take therefore as initial criteria 50 megawatts of heat minimum at $50 per kw and 10 cents per million Btu. Unless these criteria make the application look promising, there is no present basis for further consideration. If it does appear justified, a reasonable design study effort would be indicated and conversations with equipment manufacturers over the next few years profitable.

With most heterogeneous uranium metal, power reactor designs, the transitions in uranium (which occurs at 663 C, produces a 1 per cent change in density and serious distortions in fuel elements) has been accepted as a design limitation. There are some who believe this limitation is not real, because by passing through this temperature once for continuous operation at higher temperature, one would avoid the effects of cycling. Others have been seeking an uranium alloy which does not have such an effect.

There is also a uranium-iron eutectic which forms at 735 C which has been a limitation on design temperature. For these reasons, it is probably wise to assume about 1200 F as a present maximum temperature from such reactors.

The developments of liquid metal reactors like the LMFR (liquid metal fuel reactor) of Brookhaven design and of ceramic fuel elements may quickly take us past this limitation. If so, there is little reason to stop short of 2300 F at which point the structure of the reactor and the heat exchangers will begin to be a problem.

If one accepts these estimates for nuclear power, the combustion engineer can examine various spots in the present processing where energy costs are significant. Republic's first study was a proposed replacement of blast furnace top gas as heating fuel for stoves by a reactor. This application calls for about 40 megawatts of heat per furnace. Our investment for reactors was

* At time of paper presentation. Now President, Applied Research, Inc., Chicago, Ill.

....so far no one can say for sure what effect nuclear technology will have on the steel industry....some of the possibilities are explored in the following paper....

THE STEEL INDUSTRY

taken at $60 per kw of heat. The graph in Figure 2 shows how the return on investment depends on the value of the top gas. Where one bleeds this gas to the atmosphere, that is, gives the by-product gas zero value, even reactors will not compete. In other economic conditions, it is evident such fluid fuel will have considerable value, since it can yield temperatures now of 2800 F where you want it.

The return on investment is not sufficient to justify immediate interest, but as reactor technology retires the technical risks, and gas turbines begin to transform top gas to electricity at good efficiencies, one might well look for reactors as air blast heaters. The effect of higher temperatures on the economy of blast furnace is well known and justifies all present efforts on ceramics and burden preparation.

Other applications worth considering are roasting of non-magnetic ore for beneficiation prior to shipment, and naturally, preparation of sponge iron at ore sites especially where extensive grinding and beneficiation already exists.

Any corporation large enough to recognize a department of combustion engineering ought to see to it that one of its engineers becomes familiar with the potentials of nuclear energy. A growing list of reference material, as well as nuclear engineering courses in most of the technological schools, makes this possible.

Turning now to other aspects of nuclear technology, let us consider the area of liquid metal heat exchange. The fast breeder reactor employed a sodium potassium coolant (NAK) and operated for three years without difficulty in its use. Additional experience from SIR, SGR, EBR No. 2, LMFR (submarine intermediate reactor, sodium graphite reactor, experimental breeder reactor No. 2, liquid metal fuel reactor), etc., will confirm the reliability of coolant circuits using sealed electro-magnetic pumps and liquid metals. A summary of data in this field may be found in the Liquid Metals Handbook, Department of Commerce, U. S. Printing Office. Since the NAK probably can be operated at 1200 F without trouble, it seems that two advantages could accrue; one is the potential improved behavior of ceramic materials, the other reduction of temperature gradient and therefore heat losses. In steelmaking furnaces, temperatures of 2700 F being common, if the wall, grates, doors, etc., could be held at 1200 F instead of the 200 F necessitated by use of water, the temperature gradient, and therefore the heat losses, ought to be substantially reduced. The other factor which might be particularly helpful for programs like continuous casting, depends also on the high heat transfer rate. With slight changes in pumping rates, very close temperature control should be possible at the high temperatures involved in continuous casting. The advantages discussed above are equally applicable to fused salt or organic fluid cooling. Until engineers examine this field, the use of water while understandable, may not be necessarily optional. It would be

Figure 1 — Chart shows reactor costs in terms of dollars per kilowatt of heating.

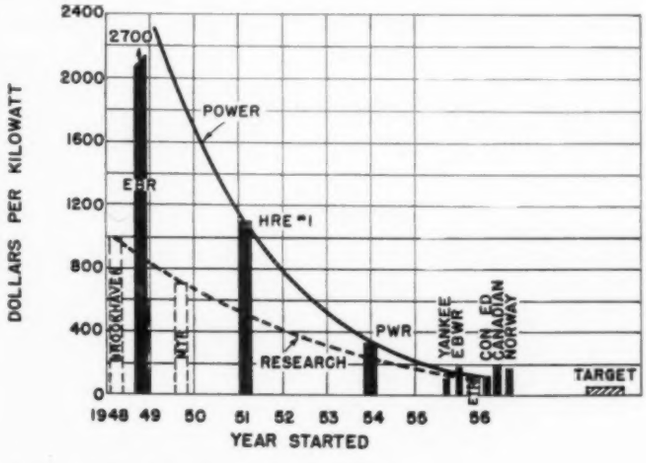
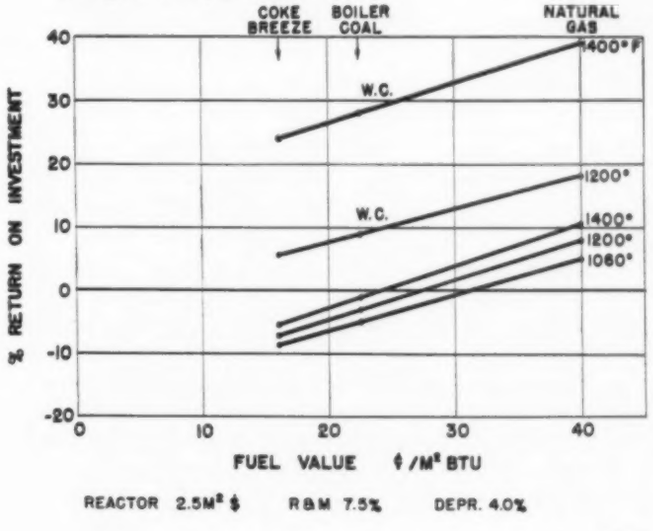


Figure 2 — The return on the investment in reactors for blast furnace stoves depends on the value of the top gas. The curves labeled w.c. include a credit to the reactor for the economies of operating blast furnace at higher temperatures.



well to keep in touch with the reactor designer who has no choice except to intensively develop this particular technology.

A second technology relates to the possibilities of doing quick chemistry. Usually we think of neutron excitation as a method of detecting microgram quantities of a material. The method involves bombarding the specimen with a neutron source—a reactor or radium beryllium for example. The product $nt_eN_j\sigma_j$ (N, being the number of atoms of j^{th} kind present, σ_j being the cross section of hat atom, and n the number of neutrons passing through the specimen per second, t_e the time of exposure) gives the number of atoms of type j which capture a neutron and are transmuted to another atom which may be radioactive. If it is radioactive with a decay constant λ_j, we will get an initial rate of disintegration of $nt_e\sigma_jN_j\lambda_j$ per second.

N counts of disintegrations will determine the rate of disintegration with a relative probable error given by $\frac{0.67\sqrt{N}}{N}$. Counting 10,000 counts will yield a relative probable error, then of 0.67 per cent. To count 10,000 events in good geometry will require $10{,}000 \times 10 = 10^5$ disintegrations. To obtain this number in one minute, we will need 1600 disintegrations per second.

Since sources of neutrons are available with 2×10^7 neutrons per second, we can in 60 seconds of exposure obtain a disintegration rate of $2 \times 10^7 \times 60 \times \sigma_jN_j\lambda_j$. Setting these two rates equal, we find that we can analyze with a precision of 1 per cent in 2 or 3 minutes any material for which $\sigma_jN_j\lambda_j \geq \frac{1.6 \times 10^3}{1.2 \times 10^9} = 1.33 \times 10^{-6}$.

Now: $N_j = 6.03 \times 10^{23}(m_jE_j/M_j)$ where m_j is the grams of item j, E_j is per cent of isotope to be exited, and M_j is its molecular weight. If σ_j is measured in barns, that is, units of 10^{-24} cm^2 and the half life is measured in days, we can rewrite this condition as:

$$\sigma_j \frac{m_jE_j}{M_j} \frac{1}{t_{\frac{1}{2}}} \geq \frac{1}{10}$$

or

$$m_j \geq \frac{M_jt_{\frac{1}{2}}}{10\sigma_jE_j}$$

Thus:

	M_j	$t_{1/2}$	σ_j	E_j	Required m for 3-min analysis grams
P	31	14	0.2	1.	217
K	42	0.5	1	0.07	30
S	28	0.1	0.1	0.03	93
C	40	0.006	1	0.002	12
N	59	0.1	3	0.01	20

On increasing the source of neutrons, extending the time, etc., it would seem that this principle might fit into the production of steel, titanium, or other product, as it already has in the organic material production. It might be pointed out, too, that other particles, such as protons might be used for such excitations.

The power of tracers in examining processes of steelmaking may best be shown by describing an experiment performed under sponsorship of R. P. Liggett, chairman of blast furnace committee, Republic Steel Corp. in cooperation with the staff of National Lead Co.

Suppose a blast furnace is making 10,000 lb of flue dust per hour corresponding, say, to a rate of 266 lb per ton of pig or to 5 per cent of ore added. When a change is made in the burden by adding 7 per cent pellets, assuming the pellet makes either 0 or 5 per cent dust, we would have either 10,000 or 10,700 lb per hr of dust. To determine the flue dust made by the pellets to an accuracy of 10 per cent that is to determine that the flue dust contains 5 per cent and not 5.5 per cent of the pellets, will then require a measurement of 70 lb in 10,700 lb of flue dust. It is easy to see with holdups in the flue dust bin and variations in the wind blown, etc., that the chances of such a precision are nil.

When iron ore is placed in a region of large neutron flux (such as occurs in a reactor) some of the atoms of iron with atomic weight 58 (about 0.3 per cent of iron has this weight) will capture a neutron and will become radioactive with a half life of 46 days. That is, they are iron atoms and behave in all chemical reactions, such as reduction and slagging, just as all other iron atoms, but on the average, one half of these converted atoms will give off a detectable radiation (either a 1.1 mev X-ray or a 1.3 mev X-ray) within each 46 days. Then by placing small samples (5 to 25 gram) of flue dust or pig iron in a counting equipment, it is possible to determine quite precisely the amount of the originally added radioactive material which appears in the sample.

With the radioactive methods available, one can conveniently work with 40 counts per minute. After two weeks in the reactor, we find that 2000 grams of pellet yield nearly 2×10^{10} counts per minute. For each 0.1 per cent of the pellet carried over we have 2×10^7 counts per minute. If we take a sample of 2000 grams out of the flue dust made in 6 hours (time between casts)—that is 60,000 lb, we will obtain a fraction $\left(\frac{2000}{60{,}000 \times 454}\right)$ of the 2×10^7 counts per minute or 1470 counts per minute in our sample. Thus we see that counting to a precision of 0.1 per cent of the flue dust make is possible. We still, of course, have the problem of showing that a 2000-gram sample is really representative of the 60,000 pounds but repeated sampling allows us to establish this statistically.

The appearance of radioactivity in the flue dust, or pig also gives us information on the rate of movement of the pellets through the furnace and the rate of flue dust make vs time or position in the stock. It may be helpful to describe the experiment in greater detail.

PROCEDURE

Selection of pellets and irradiation—Representative pellets were irradiated at about 5×10^{11} neutrons per cm^2 per sec for a period of two weeks in the Oak Ridge reactor.

Preparation of standards—Dust was taken from each of the aluminum cans used to emplace the pellets in the reactor and the radioactivity in cpm per gram deter-

mined. Since equal numbers of pellets were in each can, the average of these counts is taken to be a measure of the cpm (count per minute) per gram of pellet. Standards were prepared using irradiated pellet dust calibrated against the established average cpm per gram. These standards were derived by adding 1 gram of "hot dust" to 1000 grams of neutral flue dust (or slag). Then an average 1-gram sample of the resulting mixture contains 1 milligram of "hot dust." When added to 2000 grams of flue dust (or slag), we obtain a standard which contains a known amount (of the order 1 milligram) of radioactive pellet per lb of sample. Since all geometric factors are held constant when comparing the samples of flue dust (or slag) to the standard samples, the ratio of counting rates is the ratio of milligram of pellet per pound of flue dust in the samples to the known milligram of pellet per pound of flue dust in the standard.

Special correction for pig—In the case of the pig, additional corrections are required. One first reduces all samples of pig (taken in the form of carbommeters broken off to a length of about 1 in.) to the same size as the standard flue dust sample and then corrects for self-absorption a factor of about 5 per cent. This self-absorption effect occurs because the gamma rays emitted the Fe^{59} will be attenuated at a higher rate per cm in the denser pig than in the flue dust.

Addition of pellets to furnace and collection of dry flue dust—Fifteen pellets were placed in skips scheduled to insure even distribution around the furnace. The six skip loads were added over a period of about an hour. These additions were preceded by emptying of the flue dust bin and spotting of a clean weighed car under the bin to catch the dust made between casts. Three cars were so weighed in order to catch radioactive material delayed in production or held up in the bin. After cooling, a composite sample was made from each eighth of the car from 12 to 15 individual samples.

Collection of wet washer—Meanwhile, collection of samples of wet washer effluent was made by compositing for periods of ½ hour. Interest in the rates of wet washed to dry dust is related to the fact that before pelletizing, the ore is ground to 300 mesh for magnetic beneficiation. The detail structure of the material being unusually fine it might be expected to behave differently than normal burden with respect to this ratio of wet to dry dust.

Collection of slag and pig iron samples—During each flush, small spoons of slag were taken at reasonably constant intervals resulting in one, two, or even three slag samples per flush. Pig iron samples were obtained using an open hearth carbommeter. Samples were taken at each five minutes adjusted by the collector to reflect radical variation in flow rates.

Figure 3 shows a typical result. The experiment will be reported in greater detail in a later paper. The usefulness of this technology and its ease of application ought to encourage a wide spread use of tracers in steel.

The application just described shows how tracers may be used for studying processes. At later stages of such studies, we may expect that isotopes may assist in control. The application to rolling mills of thickness gages, to cupola furnaces of height gages, to slurries for density measurement are typical of the already existent production applications.

Turning now to the market effect on the steel industry of this new business, it is not surprising that the containment of corrosive coolant, cladding of chemically active uranium, and work areas of chemical separation plants should call for alloy steels, particularly as temperatures needed for electrical generation are attained. We find, indeed, that much stainless goes into reactor structures, perhaps as much as 100 tons per reactor in present designs. Other products not so common to our regular steel production have appeared. There is the area of cladded plates needed for the very large pressure vessels contemplated in this business (12 ft in diameter and 15 ft long). There is stainless steel with boron for control rods. There has been considerable interest in stainless steel with boron up to 1 ½ per cent to be used as a thermal neutron shield between the core and pressure tank.

But above all, there is the need to recognize that "molecularly perfect" steel has a place, and the customer is ready to pay for it. This is a direct result of the cost or even occasionally impossibility of replacing defective components after reactor startup and the effect of radiation occurs.

Non-destructive testing of all kinds will be more and more in demand as we move into the nuclear field. This will present continuing challenges to steelmen.

In this brief sketch of relationship between steel and nuclear technology, it has been necessary to forecast areas of potential accomplishment or applicability rather than give a comprehensive review of accomplishment. This reflects on the age of this new technology, but more particularly on the lack of technicians and engineers trained in isotope techniques. Our experience suggests that the best training can be done by actual conduct of experiments, because management interest is encouraged and sustained by new and interesting data on familiar processes obtained during the training period.

DISCUSSION

PRESENTED BY

KARL L. FETTERS, Assistant Vice President, Youngstown Sheet and Tube Co., Youngstown, Ohio

THOMAS L. NABORS, Combustion Engineer, Republic Steel Corp., Gadsden, Ala.

DR. R. P. PETERSEN, Director Nuclear Research, Republic Steel Corp., Cleveland, Ohio

R. F. McCARTNEY, Supervising Technologist, United States Steel Corp., Research and Technology Laboratory, Monroeville, Pa.

Karl L. Fetters: A very quick calculation would indicate the figure of 10¢ per million Btu would just about correspond to the $2.50 ton coal, which is a nice price if you can get it. Are we fairly close?

Thomas L. Nabors: I would like Dr. Petersen to elaborate a little on the questions regarding who will reprocess the fuel, and that of waste disposal.

R. P. Petersen: One does not belittle the problem of waste disposal because the amount of radioactivity

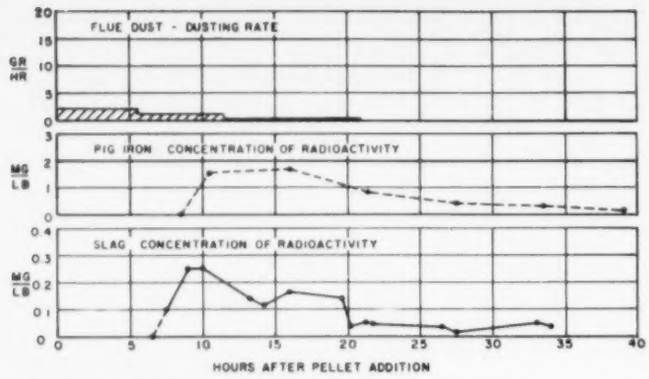


Figure 3 — Curves give a typical result on pellet test made on Furnace No. 2 at Gadsden, Ala.

generated will, of course, be equivalent to many, many tons of radium and one certainly does not want to be throwing it around indiscriminately. However, there are large regions, desert regions, rock regions, large oceans and many ways in which these fission products can be fixed.

The most desirable way of getting rid of them would be, of course, to put them in a clay which could then be fired and, therefore, lock these fission fragments into a fired clay which then would be disposable in the depths of the ocean and, presumably, while eventually wearing away, give the radioactive product a chance to decay.

The worst situation, I think, would be that you store it in stainless steel tanks somewhere in the desert. Calculations suggest that this would add a cost of about a tenth of a mill per kwhr to fuel costs. This is certainly tolerable. It, therefore, is not true that the problem has not been overcome in the sense that you talk about it, since a tenth of a mill per kwhr is not a problem economically. It is still a chore, and a nasty mess, and much effort is going into it. This, of course, is certainly not going to stop the business from coming along.

Thomas L. Nabors: On reprocessing, did you mention that the fuel must be reprocessed after about one per cent burn-out usage? Who will reprocess it?

R. P. Petersen: At the present time the government is the only agency that has the facility for accepting highly radioactive materials for reprocessing. They use a wet chemistry process, which means dissolving the radioactive fuel element in nitrochloric acid. From this point on, your chemistry must be done automatically behind barriers four and five feet thick; with the problems of pumping radioactive material from one barrier to another, and the problems of going into the cells and cleaning out any spills that you might have.

This plant was a very expensive plant because of these shielding requirements. The government is the only one that had either the amount of capital required or the business to justify building such a plant. As one goes into the business and gets four, five or six power plants to serve, then private industry can come in and pick up this problem of reprocessing.

There are two methods of reprocessing. One is the wet chemistry process, which involves dissolving fuel elements and other elements in nitric acid, and then proceeding with a fluid mixture. The other is a slag operation, just as used in the open hearth, of actually heating the fuel element up to a molten temperature, placing it in contact with materials like silver, uranium, thorium and actually causing a slagging off of the impurities that have developed.

R. F. McCartney: Is your prediction of 10 cents per million Btu's based on the economics of a breeder-type reactor?

R. P. Petersen: There are many kinds of reactors. My estimate is based on the type of reactor which the Norwegians, for example, are building. These are natural uranium reactors of the Hanford type, which take natural uranium fuel and then a moderator of graphite or heavy water to generate a critical reaction. They can generate any temperature which you can contain.

An alternative to using natural uranium is to use enriched reactors. An enriched reactor is one which contains a higher fraction of U-235 than natural uranium. Let us say that instead of seven-tenths it might contain two per cent fissionable U-235. Now the Oak Ridge facilities, the gaseous diffusion plant, separate this into isotopes and you use this to give you enriched fuels.

It costs a lot of money to get it enriched. The fuel costs now, instead of being $30 a pound in the reactor, are $170 a pound in the reactor. Now you must not only get long burn-out, but you no longer can afford to discard the fuel as I was doing in my natural uranium reactor. You now must, if you are going to achieve such a fuel cost, do chemical reprocessing in order that you are able to use up the enriched fuel that you have.

So, when you talk about enriched fuel cycles you must talk about chemical recycling processes and their costs. Now, the ultimate in this picture is when you enrich a reactor so much that you can talk about a breeding cycle. When you can talk about a breeding cycle, then the only cost of fuel is the initial inventory of fuel because beyond this point you are creating fissionable material out of U-238 which is essentially free—in our terms—because you are not paying very much for it.

You will still have problems. While you have a free fuel cost in one sense, you now cannot breed unless you do continuous chemistry, because if you allow fission fragments to accumulate they will steal the neutrons that you need for the breeding process. So now your chemistry costs are higher because you must do more frequent chemistry.

The British expect to get 1½ per cent burn-out in their natural uranium reactors. I believe it is considered realistic, with a conversion ratio of about 0.8. Conversion ratio means that while you burn up fissionable material, you create neutrons, which convert U-238 into plutonium in the reactor. Thus, you will be not only burning the original fissionable material that you had but also the fissionable material that you are manufacturing in the process. Eventually you have to stop because you accumulate enough fission fragments so the reactivity disappears.

I think the calculations indicate that you can get as far as the 1½ per cent point. I am not alone in being optimistic. A lot of people believe that this is going to come. The British certainly have gone down the road of natural reactors because they have not wanted to depend on diffusion plants.

PROGRAM

AISE SPRING CONFERENCE

AUSPICES OF ROLLING MILL COMMITTEE

THE NETHERLAND HILTON HOTEL CINCINNATI, OHIO

April 29, 30, May 1, 1957

MONDAY, APRIL 29, 1957

8:30 am—REGISTRATION—
Fourth Floor Foyer, The Netherland Hilton Hotel

9:00 am—ROLLING MILL SESSION—
Pavillon Caprice

Chairmen: Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

R. C. Schaefer, Superintendent Hot Strip Mill, Wheeling Steel Corp., Steubenville, Ohio

"Recent Developments in Slabbing Mills," by H. J. Kalberkamp, Chief Engineer, Mesta Machine Co., Pittsburgh, Pa.

"Roll Design for a Combination Wide Flange Beam and Structural Mill," by Herman E. Muller, Superintendent Roll Dept., Inland Steel Co., East Chicago, Ind.

"Mechanical Manipulation in Bar Mills," by E. C. Peterson, Vice President, Rolling Mill Equipment Div., Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

9:00 am—ELECTRICAL SESSION—
North Hall

Chairmen: R. G. Nolan, Electrical Engineer, Granite City Steel Co., Granite City, Ill.

D. C. McCrady, Superintendent Electrical Dept., Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

"Electrical Drive System for a High Speed Combination Rod Mill," by A. F. Kenyon, Advisory Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., and H. J. Oakes, Senior Engineer, Systems Control Dept., Westinghouse Electric Corp., Buffalo, N. Y.

"Electrical Equipment for a Modern Rod Mill," by E. L. Anderson, Superintendent Electrical Dept., Bethlehem Steel Co., Johnstown, Pa.

"Methods of Control of Strip Thickness on Hot Strip Finishing Mills," by R. A. Phillips, Control Systems, Analytical Engineering Section, General Electric Co., Schenectady, N. Y.

2:00 pm—ROLLING MILL SESSION—
Pavillon Caprice

Chairmen: F. G. Kredel, Chairman, Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio

A. M. Cameron, Superintendent Blooming & Bar Mills, Atlas Steels, Ltd., Welland, Ontario, Canada

"American Steel and Wire's New Rod Mill," by W. V. Magee, Assistant Chief Engineer, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio

"A Combination Mill for the Rolling of Strip, Rods and Bars," by Ernest E. Davis, Superintendent of the Hot Mills, Carpenter Steel Co., Reading, Pa.

"Algoma's Combination Bar and Strip Mill," by W. H. Mulflur, Division Superintendent, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada

2:00 pm—COMBUSTION SESSION—
North Hall

Chairmen: R. A. Lambert, Superintendent Steam & Combustion, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

F. B. Bevelheimer, Power & Fuel Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Billet Heating-New Johnstown Rod Mill," by F. R. Pullen, Fuel Engineer, Johnstown Plant, Bethlehem Steel Co., Johnstown, Pa.

"Rapid-Acceleration Heating Features on the Soaking Pits at Fairless Works," by J. Leo Hagan, Fuel Engineer, Rolling Div., United States Steel Corp., Fairless Works, Fairless Hills, Pa.

"Recent Developments in Metallic Recuperators," by Thomas E. Dixon, Vice President, and Heinz A. Kuhne, Vice President, Griscom-Russell-Schack Co., Inc., Pittsburgh, Pa.

TUESDAY, APRIL 30, 1957

9:00 am—ROLLING MILL SESSION— Pavillon Caprice

Chairmen: R. P. Schuler, Superintendent, Cold Strip Dept., Inland Steel Co., East Chicago, Ind.

Howard S. Orr, Project Development Engineer, Rolling Mills, U. S. Steel Corp., Pittsburgh, Pa.

"Turn-up and Turn-down in Hot Rolling," by G. E. Kennedy, Technologist, and F. Slamar, Research Engineer, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

"Resume of Operating Methods of Canada's Continuous Hot Strip Mill," by R. J. Barry, Superintendent, Plate & Strip Mill, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

"The Planetary Hot Strip Mill and Its Uses," by T. Sendzimir, The Sendzimir Co., Waterbury, Conn.

9:00 am—MECHANICAL SESSION— North Hall

Chairmen: H. R. Knust, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.

Charles H. Good, Jr., Chief Engineer, United States Steel Corp., Duquesne Works, Duquesne, Pa.

"Current Status of Spindle Slipper Lubrication," by Wayne G. Ritter, Trabon Engineering Corp., Pittsburgh, Pa.

"Primary Mill Roll Neck Bearings and Their Protection," by George Sackerson, Superintendent, Blooming Mills, Billet Mills, Rail Mill, Splice Bar and Tie Plate Shops, Bethlehem Steel Co., Lackawanna, N. Y.

"Crowned Tooth Gear Type Couplings—Their Development and Application with Particular Reference to the Steel Industry," by Frank W. Zurn, Vice President—Sales, American Flexible Coupling Div., Zurn Industries, Inc., Erie, Pa.

2:00 pm—OFF-THE-RECORD ROLLING MILL PANEL DISCUSSION—Pavillon Caprice

Moderator: Don C. Horsman, Plant Superintendent, Continental Steel Corp., Kokomo, Ind.

The following topics will be covered in this panel discussion:

(1) Guide application and materials on rod and merchant mills (including roller guides).

Panel: R. H. Custer, Assistant Superintendent 8-10-12-In. Bar Mills, Bethlehem Steel Co., Lackawanna, N.Y.; Robert Gourlay, Chief Roll Designer, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada; Arthur H. Griffiths, Superintendent of Mills, Sheffield Steel Div., Armco Steel Corp., Kansas City, Mo.; C. S. Lambert, Superintendent Merchant Mills, Youngstown Sheet and Tube Co., Campbell Works, Youngstown, Ohio; D. W. McLean, Assistant Superintendent, Merchant Mills, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada; M. T. Magee, Division Superintendent, Rod Mills, American Steel & Wire Div., United States Steel Corp., Donora, Pa.; F. F. Zipf, Superintendent Roll Dept., Bethlehem Steel Co., Johnstown, Pa.

(2) Cooling rod and merchant coils (finishing temperatures, cooling methods, cooling pipe applications, cooling in coilers, cooling on conveyor, etc.).

Panel: C. H. Burden, Assistant Chief Plant Engineer, John A. Roebling's Sons Corp., Trenton, N.J.; G. R. Neff, Division Superintendent, Hot Mills, American Steel & Wire Div., United States Steel Corp., Joliet, Ill.; F. T. Van Camp, Night Superintendent, Wickwire Spencer Div., Colorado Fuel and Iron Corp., Buffalo, N.Y.

(3) Time-saving ideas in roll changing.

Panel: F. G. Kredel, Chairman, Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio; Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.; J. A. Tischbein, Assistant Superintendent Continuous Sheet and Strip Dept., Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

(4) Practices used in polishing finishing passes in rod and merchant mills.

Panel: V. W. Johnson, Superintendent Rolling and Finishing, Colorado Fuel and Iron Corp., Pueblo, Colo.; Wm. H. Mohler, Superintendent, Roll Department, United States Steel Corp., McDonald, Ohio; Sheridan A. Smith, Superintendent, Rolling, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

(5) Cutting deformations for reinforced concrete lug bars.

Panel: H. W. Evans, Roll Designer, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada; P. E. Evans, Roll Designer, Calumet Steel Div., Borg-Warner Corp., Chicago Heights, Ill.; M. L. Weikert, Superintendent Roll Shops, Bethlehem Steel Co., Sparrows Point, Md.

7:00 pm—INFORMAL STAG DINNER— Hall of Mirrors (3rd Floor)

Speaker: R. L. Gray, President, Armco Steel Corp.

WEDNESDAY, MAY 1, 1957

8:30 am—INSPECTION TRIP—

Detroit Steel Corp., Portsmouth Div., Portsmouth, Ohio. Buses will leave from Netherland Hilton Hotel. Because of luncheon arrangements, tickets for trip must be picked up by noon April 30.

CONFERENCE CHAIRMEN

LOUIS MOSES

R. C. SCHAEFER

RICHARD G. NOLAN

D. C. McCRADY

F. G. KREDEL

A. M. CAMERON

R. A. LAMBERT

F. B. BEVELHEIMER

R. P. SCHULER

H. S. ORR

H. R. KNUST

CHARLES H. GOOD, JR.

DON C. HORSMAN

Abstracts of Technical Papers

to be presented at technical sessions of

AISE SPRING CONFERENCE

April 29, 30, May 1, 1957

THE NETHERLAND HILTON HOTEL CINCINNATI, OHIO

"RECENT DEVELOPMENTS IN SLABBING MILLS"

by H. J. KALBERKAMP, Chief Engineer, Mesta Machine Co., Pittsburgh, Pa.

H. J. KALBERKAMP

▲ AS part of the large expansion in the steel industry over the last several years and as part of plans for the immediate future; a number of primary rolling mills have been built and several such mills are now under construction. A renewed interest in universal slabbing mills developed as maximum capacity was demanded from the mills intended for the production of slabs for strip and plate mills.

There has been a reversal of trends in the selection of the slabbing mills. Until about twenty-five years ago most mills intended for slab rolling were of the universal type. The disadvantages and short comings of this type of mill as then in use led to the development of the high lift, two high mill with high screw-down speeds. The demand for maximum capacity and also the demand for producing slabs of sufficient width for eliminating or minimizing cross rolling in the wider strip mills has reversed the trend toward mills of the universal type.

The universal mill of modern design is a mill greatly improved over older designs. However, if the ultimate in capacity is not required, and slabs no wider than about 62 in. are to be produced, the selection of a two high, high lift mill should be given most serious consideration as such a mill has major advantages over the universal mill.

"MECHANICAL MANIPULATION IN BAR MILLS"

by E. C. PETERSON, Vice President, Rolling Mill Equipment Div., Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

▲ Three-high roughing mills were originally served manually by hooker and rougher. Tilting tables

E. C. PETERSON

have been added to reduce the labor of lifting to the top pass. Various types of dragovers have been added to these tables to move the bar from pass to pass. Finally turning devices have been added to turn the bars up where required for the next pass.

In intermediate and finishing mills, bars are handled by running out straight or looping. Straight work can be handled by runout and runin tables with dragover transfers, skew tables, Y-tables with front end transfers or by pivoting troughs. On 3-high mills, various devices for dropping and sliding the bar from pass to pass and from stand to stand are available.

In straight work, turning devices are required which will turn the bar up for succeeding passes as it runs toward the next pass. Both stationary and mechanically actuated devices are used.

Looping was originally done by hand, but today repeaters are used at many points. These repeaters can be of stationary or breakout type, or they can have provisions for mechanical escapement.

The use of mechanical handling equipment in bar mills has made it necessary to modify the equipment for cropping bars, and both stationary and flying shears are used.

"ROLL DESIGN FOR A COMBINATION WIDE FLANGE BEAM AND STRUCTURAL MILL"

by HERMAN E. MULLER, Superintendent Roll Dept., Inland Steel Co., East Chicago, Ind.

H. E. MULLER

▲ THE rising demand for wide flange beams, particularly in the lighter foot weights, is the result of architectural trends and the needs of the construction industry. A few years ago, it became apparent to the management of the Inland Steel Company, that another wide flange beam mill would find a market in the Chicago area. After some

market research, it was decided to concentrate on the production of more popular sections and lighter wide flange beams. In our situation it was obvious that we could not justify building an entirely new facility. The result of the planning effort was a decision to modify our 28-in. mill to roll wide flange beams. At that time the mill was producing standard structural shapes, rails, bars and miscellaneous shapes.

One of the considerations in laying out the modified mill was the type and size of sections to be rolled, the method of rolling and roll design. After some deliberation, it was decided to produce only parallel flange wide flange beams with no taper on the inside of the flanges. This decision dictated the application of the Puppe or flared flange method as practiced by U. S. Steel Corp. in mills at Homestead and South Works. We were cognizant of the fact that we would have to use as much of the existing mill facilities as possible, and that the roughing work would have to be performed on the existing 46-in. bloomer, 32-in., 2-high reversing mill and one of the existing 3-high stands of the 28-in. mill. We considered using one or two reversing universal stands for breakdown, but were influenced by cost considerations in limiting the Universal breakdown mill to a single stand. At first, we intended to use the 28-in. mill roughing stand for just one sizing pass. Later on, we saw the advantage of performing some of the additional forming in the 28-in., 3-high mill, particularly on the lighter sections. This then outlined our roll design. We realized that we would be limited to this rolling practice; one finishing universal mill, one pass to straighten flanges; intermediate universal mill, three to nine passes depending on the size of the section; 32-in. breakdown mill, five to seven passes depending on the size of the section (preferably five passes); blooming mill, to roll a beam blank if necessary (preferably a bloom depending on various factors).

One of the major roll design problems was to furnish a beam blank to the universal mill of such proportion that a minimum number of passes would be required in the universal mill. This meant that the conventional rolling preceding the universal passes must be by tongue and groove passes with heavy flange and web work. We knew that the flange to web thickness ratio in these early tongue and groove passes would have to be high. This is at variance with the situation when rolling standard beams. We found that we would have to have less taper on the inside of the flanges than on standard beam passes, and that we would have to work off the taper very fast in these sequences. We were also confronted with roll strength problems because the dead holes and recesses were to be deep. We tried to exploit the spread phenomena in the universal mill as much as possible by over-drafting the flanges. This also prevents web buckling. The necessary heavy drafts in our 32-in. mill were of great concern to us. We spent much time considering such factors as the possibility of slippage, insufficient power, roll breakage, roll analysis, collar strength, and the possibility of raising the pitch of the mill to extreme limits. We approached the limit of all physical dimensions of rolls and rest bars. There were some challenging problems throughout the project. From the start of trials, we were fortunate in being able to roll commercially salable bars on every rolling. We did not have to go off a scheduled order at any time. We encountered some trouble with web buckling and long flanges on some sections. Alterations were made after initial rollings in order to improve the sections and to help the rollers get section faster and to hold more uniform mean tolerances. Graphic tabular setup schedules for each section are issued by the roll department so that the roller and his crew can reproduce settings as accurately as possible. These setup schedules are revised with each change in drafting practice and are adhered to closely by the mill.

"METHODS OF CONTROL OF STRIP THICKNESS ON HOT STRIP FINISHING MILLS"

by R. A. PHILLIPS, Control Systems, Analytical Engineering Section, General Electric Co., Schenectady, N. Y.

R. A. PHILLIPS

▲ THIS paper relates to methods for closer control of strip thickness on tandem hot strip finishing trains by electrical means. It relates more specifically to the application of theory in the selection of suitable means. Such approach is desirable because of the many means to be considered and the high cost of testing and using pilot equipment. To our knowledge no automatic gage control system is presently in operation and this paper may assist in shortening the time required to produce improved thickness control.

The various causes of the deviation in the finished strip and present manual means of minimizing these deviations are reviewed. An explanation of theoretical mill behavior is used to account for present practices. This leads to a discussion of various methods of reducing strip thickness variation.

Charts are presented showing traces of the more important variables under transient and steady state conditions using several closed-loop regulating systems. The use of theory and analog computer techniques makes possible the selection of the most promising systems from among the several possibilities.

A prediction of the sequence of steps likely to be taken toward obtaining closer gage control is made and discussed.

"ELECTRICAL EQUIPMENT FOR A MODERN ROD MILL"

by E. L. ANDERSON, Superintendent Electrical Dept., Bethlehem Steel Co., Johnstown, Pa.

▲ THIS paper discusses electrical equipment for a modern 3-strand, high speed, 23-stand rod mill, driven by 11 motors totalling 7450 hp. The mill is designed for rolling in coils, rods of sizes $\frac{7}{32}$ in. to $\frac{3}{4}$ in. in diameter.

Power is purchased from the local utility at 23,000

E. L. ANDERSON

volt, 3-phase, 60 cycle and is converted to 700 volts direct current through three mercury arc rectifiers, having a total capacity of 5500 kw.

Operation of the rectifiers, main drive equipment, auxiliary equipment, such as pouring and laying reels conveyor is discussed along with the problems presented by the rectifiers in interference with communication systems, the effect of surges on the power company's system on the operation of the rectifiers, and main drive equipment.

Tabulations show motors on the main drive and auxiliary drives and photographs cover the installation of the various component parts.

The main drive motors are of the normal inertia type with a high speed regulating system rather than the conventional high inertia armature that has been applied on other mills.

"ELECTRICAL DRIVE SYSTEM FOR A HIGH SPEED COMBINATION ROD MILL"

by A. F. KENYON, Advisory Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., and H. J. OAKES, Senior Engineer, Systems Control Dept., Westinghouse Electric Corp., Buffalo, N. Y.

A. F. KENYON

▲ THE paper describes the electrical drive equipment and control and regulating systems for a new twenty-five stand high speed combination rod mill recently installed at a northern Ohio plant. The mill is designed to roll from 3¼ in. square by 34-ft long billets and thereby produce 1200-lb rod bundles; to operate at up to 6500 fpm maximum delivery speed, and to roll four strands side-by-side throughout the mill, thus providing very high output capacity.

The 13,500-hp total capacity of the nine main drive motors establishes a record high for this type of mill, and the electrical drive equipment incorporates many new features. The roughing, intermediate, and finishing mill motors are operated from three independent bus sections, supplied by two 2920-kw and one 3500-kw, 700-volt ignitron rectifiers. The rectifier power transformers are equipped with load tap changers to enable d-c voltage adjustment from 410 to 700 volts, and the required voltages for any schedule are regulated by magnetic amplifier type voltage regulators. The motors are started and brought up to speed by rectifier voltage control.

H. J. OAKES

The mill main drive motors are designed on a very conservative basis to obtain good inherent transient and steady state speed performance. Also each motor is controlled by a magnetic amplifier type speed regulator to obtain the over-all speed regulation which is necessary for successful operation of this high speed multi-strand continuous mill.

The paper is presented in two parts, the first part describing the over-all arrangement of the mill and its electrical drive, and the second part gives a more detailed description of the control and regulating systems.

"AMERICAN STEEL AND WIRE'S NEW ROD MILL"

by W. V. MAGEE, Assistant Chief Engineer, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio

W. V. MAGEE

▲ THIS paper presents a detailed description of the rod mill recently put in operation by the American Steel and Wire Division of United States Steel Corporation at their Cuyahoga Works in Cleveland, Ohio. This mill is considered to be the most modern rod mill in the world with the fastest delivery speed and highest rated tonnage on all sizes rolled.

This mill uses one standard size billet 3¼ x 3¼ in. x 34 ft long weighing 1200 lbs. These are received by railroad cars and trucks from the producing mill. They are unloaded by EOT cranes and stored in one of two billet yards until needed and are then taken to a billet separator. The billet separator places the billets one at a time on the furnace run-in table.

The billet heating furnace has a primary and secondary heating zone with top firing in both zones. The effective heating length is 70 ft and the inside furnace width is 38 ft. The fuel used can be natural gas, coke oven gas, oil or a combination of coke oven and natural gas. The pushout for discharging billets from the furnace has electrically driven rolls and hydraulically driven lateral movement.

A four-way billet switch is located on the discharge side which is hydraulically operated. Also on the discharge side there are pinch rollers adjacent to the door which can aid in feeding the billets into the mill, or if necessary to return billets into the furnace.

The mill proper consists of a total of 25 stands, 23 of which are arranged in a straight line for rolling sizes up to and including $^{27}/_{64}$. For sizes over $^{7}/_{16}$ in. the rods are diverted after No. 15 stand and are repeated through two separately driven stands. Electric flying shears located after No. 9 stand crop off the entering end to insure proper entering in the intermediate and finishing stands.

The continuous stands deliver rods to eight laying type reels and the looping stands deliver to eight pouring type reels. All reels discharge rods onto two collecting drag conveyors which in turn transfer them to two cooling drag conveyors. By means of an automatic transfer, the bundles are taken from the drag conveyors and placed on a hook conveyor. This hook

conveyor carries the rods to the inspection and bundling area and to the bundle unloading equipment.

The bundle unloaders remove the coils from the hook conveyor and assemble them into pin loads of five bundles each. These are placed on a movable table and removed by an overhead crane equipped with a hairpin hook for delivery to stock bins or to wire mill buggies.

During the presentation of the paper slides illustrate the general layout of the mill, cross sections through the mill buildings, and colored views of the principal pieces of equipment.

Charts show the maximum and minimum roll diameters of all stands and also the distribution of passes on the rolls.

"A COMBINATION MILL FOR THE ROLLING OF STRIP, RODS AND BARS"

by ERNEST E. DAVIS, Superintendent of Hot Mills, Carpenter Steel Co., Reading, Pa.

E. E. DAVIS

▲ A company which specializes in small orders of high quality steels has a particular problem in modernizing its mills. The combination of short cycles, many sizes of products of various analyses, and high production with emphasis on quality, taxes the ingenuity of mill engineers and operating people. The new mill at the Carpenter Steel Co., was the forerunner of the many combination mills which are proving so versatile to the smaller companies.

This mill uses a small 2-high reversing mill in combination with an 18 in., 3-high stand for the initial breakdown passes. The 2-high mill is used for all product combinations. The 18-in. stand is used for all rod coils and some bar sizes. A seven-stand strip mill is used in combination with the 2-high mill to roll strip from 10 in. wide down to 3 in. wide with a mean gage of 0.120 in. thick. A five-stand bar mill is used in conjunction with the 2-high mill and at times the 18-in. stand, for bars in sizes from ⅞ up to 2 in. in diameter. For various sizes of rods, different combinations of the rod mill are used with the breakdown mills and the bar mill. By a unique system of scheduling size ranges, downtime on the mill is kept at a minimum. Many additional features make this multi-purpose mill a worthwhile tool in the specialty steel business.

"ALGOMA'S COMBINATION BAR AND STRIP MILL"

by W. H. MULFLUR, Division Superintendent, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada

▲ ALGOMA'S 30-in. combination bar and strip mill was put into operation late in 1952. The basic reasons for the combination features of the mill were to develop in a limited market a flexible operation capable of economically producing quality hot rolled sheets, strip, skelp, plate and merchant bars. With an eye to the future, provisions were made to expand the operation by splitting off as a separate operation the merchant bar part of the mill. Thus it was expected to maintain full utilization of the equipment, until the normal economic growth of Canada and other allied operations in the plant would support both a modern hot strip mill and a modern merchant mill.

The mill is unique in several respects. As a hot rolled flat product mill, it consists of eleven horizontal stands and five edgers, with the attendant vertical coilers, hot flying shears and piler, as well as a plate run-out line and plate shear. As a merchant bar operation it consists of thirteen horizontal stands and five edgers, with the attendant repeaters, rotary shears, hot beds and Q-bar shears. There is also a broadside table as skew-y table for heavier sections that cannot be repeated.

Since the mill rolls both merchant bars and hot rolled flat product, provisions were made to handle both billets and slabs. A regular billet unscrambler with a hydraulic turnover works equally well on both slabs and billets. The reheating furnace is a side charge and discharge, capable of handling 30-ft slabs and billets. It originally was a two-zone furnace with a solid hearth, but was converted to a three-zone furnace with the usual water-cooled skid pipes and soaking zone hearth.

The continuous roughing mill consists of a 24-in. edger which also acts as a scalebreaker, and five 22 x 30-in. 2-high mills with a 16-in. edger between the fourth and fifth stands.

Following a 165-ft delay table is the flat rolled finishing train, or as in the case of bar rolling, the intermediate train.

When rolling sheets, strip and skelp, the finishing train is a 4-high operation. This consists of a 16-in. edger, followed by six 4-high stands. There are two 12-in. overhung edgers following the third and fifth 4-high stands.

When rolling bars, the mill becomes a 13-stand, 2-high operation with five edgers. The roughing train remains essentially the same with the exception of replacing the flat product rolls with shape rolls and installing roller twisters if needed.

The finishing train as characterized in the flat-rolled operation, becomes an intermediate train with the 4-high stands being replaced with 2-high. Following the six intermediate stands there are two cross-country 2-high stands as a leader and finisher.

Bar sections, depending on the size, may be either single or double repeated from the intermediate train through the leader and finisher, or transferred to the leader and finisher by broadside and skew-y tables.

Flexibility and simplicity of technique have been accentuated. The time necessary to accomplish a change from flat-rolled coil product to angles or rounds being under eight hours. Thus the mill can operate 20 turns per week on flat rolled, and the following week work 20 turns on bar products with one turn down for mill repairs, maintenance and changeover.

"BILLET HEATING—NEW JOHNSTOWN ROD MILL"

by F. R. PULLEN, Fuel Engineer, Johnstown Plant, Bethlehem Steel Co., Johnstown, Pa.

▲The original rod mill at Johnstown was installed about 50 years ago. At that time, a 25 x 32 ft conven-

F. R. PULLEN

tional side-charge, side-discharge, sloping hearth, billet heating furnace was installed. The furnace heated 1¾-in. square billets 30 ft long at a rate of 30 tons per hour.

In 1955, construction of a new rod mill was approved. This was to be a three-strand mill capable of average rolling rate of 40 tons per hour with an anticipated peak rolling rate of 60 tons per hour. The site of the new mill was to be the same as that occupied by the old mill. This made it absolutely necessary to keep the time for the erection of the furnace and the installation of the new mill to an absolute minimum.

To install a new furnace having a hearth area of 40 x 32 ft in the same area occupied by the old furnace in a minimum time required much detailed planning on the part of the engineering and construction departments. Since such a furnace must be almost tailor-made, it was obvious that both engineering and construction should be done by plant forces. To further complicate the problem, it was necessary to remove the old furnace stack to provide room for the new hot coil conveyor.

The site work and preliminary construction were completed prior to shut-down of the old mill on November 14, 1956. Drying-out fires were lighted on December 6, 1956, and the first billets pushed from the new furnace on December 12, 1956.

"RAPID-ACCELERATION HEATING FEATURES ON THE SOAKING PITS AT FAIRLESS WORKS"

by J. LEO HAGAN, Fuel Engineer, Rolling Division, United States Steel Corp., Fairless Works, Fairless Hills, Pa.

J. L. HAGAN

▲ THE soaking pit operation at Fairless works has been considerably improved over similar installations because of the heat acceleration principles incorporated in the original design.

By heat acceleration is meant the speed with which steel is heated in the pit. By means of a control it is possible to maintain a high fuel rate for a timed interval in order to allow the pit temperature to exceed the desired drawing temperature. Best results have been obtained with a 50 F temperature differential between the two control indices.

The control is an electronic type millivoltage instrument equipped with a double index. The first is the normal set point and the instrument can be operated in the normal manner. The second index is energized from a push button station on the panelboard. This index becomes the set point when so energized. The set point remains at the second index until the fuel flow is reduced to a pre-determined figure plus whatever length of time has been set on a timer which is energized when the gas flow reaches the pre-determined figure. This second index is incorporated into the circuit as a heat acceleration device so that during the time when the ingot is capable of absorbing heat, at a high rate without burning or melting the outside of the ingot, a temperature differential can be established between the outside and inside of the ingots in order to raise the inside temperature of the ingot.

To use heat acceleration, the operator must set the indices to the desired temperatures and set the timer for the desired time.

The degree to which acceleration can or should be used is actually a function of tapping schedules of open hearth furnaces as it relates to necessity of pit storage or fast heating to meet rolling mill schedules. Fuel economies and steel quality must also be considered along with the versatility of existing control circuits and ingot sizes. All of the above mentioned variables contribute to a constant study and revised recommended practice.

"RECENT DEVELOPMENTS IN METALLIC RECUPERATORS"

by THOMAS E. DIXON, Vice President, and HEINZ A. KUHNE, Vice President, Griscom-Russell-Schack Co., Inc., Pittsburgh, Pa.

T. E. DIXON

▲ PRIOR to 1957, metal recuperators used in the American iron and steel industry have been almost exclusively of the flue or canal type. Flue type recuperators usually consist of a series of heating elements of either tubular or extended surface (needle) design, suspended in various ways in flues conducting waste gases from the furnace to the stack.

Most of these installations have given satisfactory service at flue gas entry temperatures up to 1800 F and preheats of 700 to 900 F. It is worthy of note that many of these recuperators are preceded by tile preheaters. Since the war, a number of soaking pits in this country have been equipped with full metallic recuperation, usually in the form of a single preheater designed to serve at least three pit furnaces.

H. A. KUHNE

This arrangement helps to even out variations in flue gas temperature, and the minimum air flow through the recuperator is increased. Although flue gas entry temperatures up to 2150 F are being accepted, consistent preheats still do not exceed 950 F. There is no record of preheats of more than 1200 F achieved by using flue type recuperators on a single soaking pit. It may be argued of course that with rich fuels, preheats of 900 F are adequate. Other things being equal, however, this performance is far inferior, at least in terms of temperature, to the tile recuperators they are intended to supplant.

The authors discuss several basic reasons why flue designs have only a limited field of application and describe recuperators designed to eliminate many

of the shortcomings of the flue type. They deal with the several advantages claimed for the new design. Based on well established European practice, and adapted to suit American conditions by local operators and fabricators, units of this design will be installed on several furnaces in the American steel industry during 1957. Preheats of 1400 F are attainable with these recuperators at a very modest initial cost.

The authors also deal with the design and application of metal radiation recuperators. These units have much appeal to the soaking pit operator, particularly where he wishes to replace existing tile recuperators with a limited capital outlay. Such units are capable of accepting any temperature likely to be encountered in soaking pit operations without flue gas temperature dilution. They occupy a minimum of space—about as much as a waste gas offtake—and are practically indestructible. They are all metal, all welded construction, and thus suitable for use on the most modern high pressure combustion systems.

Combinations of the radiation recuperator and a tubular unit are also discussed, and the writers describe, briefly, metal tube preheaters suitable for preheating blast furnace wind in direct fired preheaters, fired heaters for oxygen and a variety of other applications.

"TURN-UP AND TURN-DOWN IN HOT ROLLING"

by G. E. KENNEDY, Technologist, and F. SLAMAR, Research Engineer, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

G. E. KENNEDY

▲ AN important factor in the wear of rolling-mill guides and strippers is the turn-up or turn-down of hot-rolled product delivered from a mill. In an effort to control this curvature, load-regulated twin drives have been tried on the hot-rolling mill at the applied research laboratory and although some control of curvature could be effected, the relationships were obscure. A more direct approach appeared to be speed regulation of the twin drive rather than load control.

An experiment was conducted to determine whether a rolling mill could be made to operate with a low-droop speed-regulated twin drive, and whether curvature could be controlled under conditions of filled and unfilled passes, equal and unequal roll diameters, and different angles of entry.

F. SLAMAR

The results of this test show that a low-droop speed-regulated twin-drive rolling mill can be made to operate satisfactorily and that a definite relationship exists between roll speeds and curvature. This relationship is not numerically the same for all rolling conditions, but its effect is the same for all conditions. The results also show that a change in relative roll speeds is accompanied by a redistribution of loads on the rolls.

"RESUME OF OPERATING METHODS OF CANADA'S CONTINUOUS HOT STRIP MILL"

by R. J. BARRY, Superintendent, Plate & Strip Mill, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

R. J. BARRY

▲ THIS paper describes mill operations in Canada and where apropos compares such operations with American methods. Among the items which are covered are a brief summary of the relative importance of the Canadian steel industry in the Canadian economy. The article further discusses the peculiarities of Canadian equipment and gives statistics on such equipment.

The paper also describes the results which demand and supply have on the products produced on the Canadian mills and their effect on operation.

Of a great deal of interest is the information which is given on the mill performance and statistics show how much these have been improved by changes in method. Paper also covers program on accident prevention and the results which have been obtained. Also covered is the subject of personnel, the type of employee available and the training which is used.

"CURRENT STATUS OF SPINDLE SLIPPER LUBRICATION"

by WAYNE G. RITTER, Trabon Engineering Corp., Pittsburgh, Pa.

W. G. RITTER

▲ This paper presents a resumé of the general magnitude of the slipper lubrication problem in the steel industry, discusses slipper materials, design and various schemes of lubrication as practiced in some steel plants. It presents a new and novel method for lubricating slippers on reversing mills and forecasts the possibility of use on continuous mills.

"PRIMARY MILL ROLL NECK BEARINGS AND THEIR PROTECTION"

by GEORGE SACKERSON, Superintendent Blooming Mills, Billet Mills, Rail Mill, Splice Bar and Tie Plate Shops, Bethlehem Steel Co., Lackawanna, N.Y.

▲ PERFORMANCE of mill bearings has a great deal of influence on mill yields, product quality, production, and costs of operation. Because of the low cost of bearings, they are normally considered as expendable items which are changed or replaced to maintain or improve the factors previously enumerated. Planned programs of bearing protection help operating practice. Most of these programs observe the fol-

GEORGE SACKERSON

lowing basic fundamentals: (1) Roll necks must be polished; (2) Clean, cool, and plentiful water is required; (3) A dependable grease source must be used and checked frequently; (4) Scale guards forming a tight seal are necessary when heavy scale is present; (5) Accurate records help determine and protect allowable bearing wear.

"CROWNED TOOTH GEAR TYPE COUPLINGS—THEIR DEVELOPMENT AND APPLICATION WITH PARTICULAR REFERENCE TO THE STEEL INDUSTRY"

by FRANK W. ZURN, Vice President—Sales, American Flexible Coupling Div., Zurn Industries, Inc., Erie, Pa.

F. W. ZURN

▲ NOT too many years ago little consideration was given to the problem of connecting rotating shafts. Large massive shafting, loosely mounted in sleeve bearings and joined together by rigidly bolted flanges, was the accepted method. As the tempo of industrial productivity increased, machine designers and operators were awakened to the necessity for flexibile connecting equipment and the advantages of gear type couplings became apparent. Today there are many thousands of applications where its torque, speed and misalinement capacity, with little or no maintenance, has proved its merit in design and cost. To fully understand and appreciate the many advantages of gear type couplings and the improvements made as the result of specialized engineering, this paper is composed of eight basic sections discussing:

1. Desired functions of flexible couplings in general.
2. History of gear type couplings beginning with their original introduction and improvements over recent years.
3. Improvements in gear tooth form design since the original straight sided tooth including:
   (a) Crown shaved gear tooth form.
   (b) Crown hobbed gear tooth form.
   (c) Crown shaped gear tooth form.
   (d) Other modified straight sided tooth forms.
4. Improvements in lubricant seals since the original end plate labyrinth type lubricant retainer including:
   (a) Synthetic "O" ring type seals.
   (b) Synthetic "H" or "T" cross-section type seals.
   (c) Other synthetic seals such as boot type, rising ring type, spring retainer type, etc.
5. Methods and types of lubrication for gear couplings.
6. Dynamic balancing of gear couplings.
7. Applications relating to the steel industry of standard and special fully crowned tooth gear couplings, including spindle roll drive couplings.
8. Summary of major advantages of fully crowned tooth gear couplings resulting in lower initial costs, minimum maintenance attention and longer coupling life regardless of application.

Remember the Inspection Trip!

DETROIT STEEL CORP., PORTSMOUTH PLANT

MAY 1, 1957

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Saturday, May 25, 1957—1:00 P.M.

Annual Stag Picnic

Pearl Lake, Birmingham, Ala.

BUFFALO SECTION

No May meeting

CHICAGO SECTION

Tuesday, May 7, 1957—Dinner 6:30 P.M., Meeting 7:30 P.M.

"Automatic Control in the Steel Industry," by R. W. Holman, Director, Control Mechanisms Development, U. S. Steel Corp., Pittsburgh, Pa.

Phil Smidt's Restaurant, 1205 North Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

No May Meeting

DETROIT SECTION

No May Meeting

LOS ANGELES SECTION

Monday, May 13, 1957—Dinner 6:00 P.M.

Tour through the Western Gear Plant, Lynnwood, Calif. No formal meeting.

PHILADELPHIA SECTION

No May Meeting

PITTSBURGH SECTION

No May Meeting

ST. LOUIS SECTION

Wednesday, May 22, 1957—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Transmission Problems on V Belts," by Phillip X. Navin, Assistant Manager V Belt Sales, Goodyear Tire and Rubber Co., Lincoln, Neb.

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

Tuesday, May 21, 1957—Social Hour 6:00 P.M.,

Dinner 7:00 P.M., Meeting 8:00 P.M.

Pacific States Steel Corporation Night

"Modern Trends in Forging Practices," by E. C. Thomas, General Superintendent, Pacific States Steel Corp., Niles, Calif.

Shattuck Hotel, Durant and Shattuck Streets, Berkeley, Calif.

UTAH SECTION

May 25–26, 1957

Joint Meeting with Colorado Fuel & Iron Corp.

Hotel Colorado, Glenwood Springs, Colo.

YOUNGSTOWN SECTION

Monday, May 27, 1957

Tour of new blooming mill facilities at Sharon Steel Corp., Farrell, Pa.

Dinner and Meeting, Shenango Inn, Sharon, Pa.

METALLURGICAL ANALYSIS AS A TOOL

for maintenance and operating departments

. . . . steel plant maintenance men have found that it pays to use the plant metallurgist on material problems. . . . no one is better qualified to analyze failures. . . . no one is better qualified to recommend materials. . . . better parts life and less downtime are resultant benefits. . . .

ORGANIZATION OF STEEL PLANT MAINTENANCE METALLURGICAL DEPT.

By R. H. DAVIS
Maintenance Metallurgist
Gary Steel Works
United States Steel Corp.
Gary, Ind.

▲ THE operation of an effective maintenance program requires the combined efforts of management, engineering, maintenance, operating and metallurgical personnel working together as a team.

The major objective of the maintenance department in any steel mill is to keep operating equipment running smoothly and efficiently with a minimum number of delays and at the lowest attainable cost, consistent with sound management principles. It is the primary function of the maintenance metallurgical staff to assist the maintenance department in achieving this goal.

By virtue of the training and experience of its members, a maintenance metallurgical staff may be of greatest assistance to the maintenance department by selecting the most suitable materials for each application, and by specifying the proper treatment of that material so that the optimum service life may be obtained from the parts so made. In addition, and equally important, this group must set up adequate controls in order that specifications so developed will be carried out. Although the general functions of a maintenance metallurgical staff will be essentially the same in any steel mill, the size and type of the staff required to carry out these functions will vary from plant to plant.

For this portion of this symposium a description will be given of the maintenance metallurgical unit now operating at Gary Steel Works of the United States Steel Corp. It is hoped that in so doing it might suggest a plan that will be of benefit to other plants.

This discussion will include a brief historical background of the organization, its physical make-up, the duties of the staff members and the methods used in controlling specification compliance. Finally we shall cite in a general way some of the accomplishments of the organization.

HISTORICAL BACKGROUND

For many years the metallurgist in the steel industry has played a major role in developing steels to meet changing and increasingly more rigid customer requirements. He has performed an important function in his capacity as service metallurgist, by giving aid to customers in solving their metallurgical, processing, and occasionally, their maintenance problems. The efforts of the metallurgist in plant maintenance work, meanwhile, had been confined for the most part to investigating either the failure of a part which was in need of replacement too frequently, or a failure which had caused an equipment breakdown of major consequence. As early as the middle 1930's, top management at Gary Steel Works recognized this undesirable situation and took steps to correct it. At that time a metallurgist was appointed as staff assistant to the division superintendent of maintenance, his duties being to develop specifications to cover the selection and application of maintenance parts and to investigate equipment failures. It soon became apparent that it was physically impossible for one man to perform these duties effectively. It developed that most of his time was taken up investigating equipment failures and making recommendations directed toward improvements in these areas. As a result, the performance of a few isolated items was improved, but an over-all betterment in the service life of maintenance parts was not realized. It was for this reason that the present maintenance metallurgical unit was organized.

ORGANIZATION

The maintenance metallurgical organization consists of five metallurgists and one quality inspector who work under the direction of the maintenance metallurgist. The quality inspector is assigned by the maintenance division to work under the supervision of the maintenance metallurgical department.

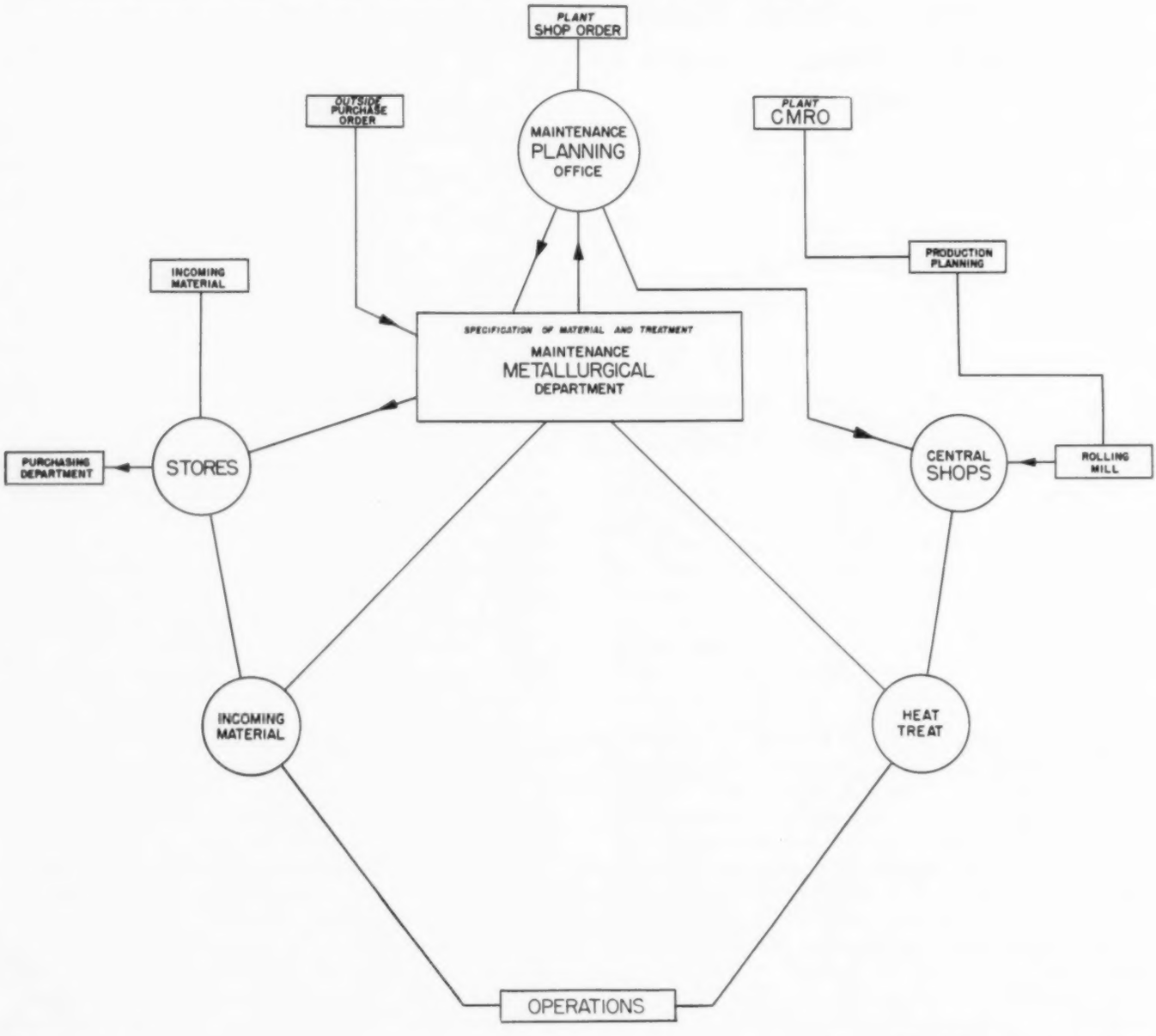
DUTIES OF THE STAFF MEMBERS

Before describing the specific duties of the staff members, reference is made to Figure 1 in order to show the position of the maintenance metallurgical organization with relation to the central plant maintenance and operating divisions and to show the flow of orders for maintenance parts in the plant. Note at the top of the chart that shop orders, originating in the various divisions, are sent to the maintenance planning office, where they are entered and sent to the maintenance metallurgical unit. After the specification is placed on the order, it is returned to the planning office for routing to the various shops involved in the manufacture of the part. Purchase order requisitions (shown at the top left on the chart), are sent directly from the ordering responsibilities to the maintenance metallurgical group for specification, then sent to the stores department which enters the orders and sends them on to the purchasing department in Pittsburgh.

Four of the five metallurgists previously mentioned are assigned to field work, one in each of the divisions into which the plant is arbitrarily divided. These divisions are made for ease of access and do not necessarily constitute a single operating unit. The specific duties of the metallurgist in each division are as follows:

1. To seek out mill conditions that need correcting. This is done by studying ordering records and delay sheets, and by daily contact with the division maintenance and operating personnel.
2. To recommend and follow test installations of new materials.

Figure 1 — Chart shows the position of the maintenance metallurgical department with relation to maintenance and operating divisions. It also shows flow of orders for maintenance parts in the plant.



3. To make disposition on out-of-specification materials.

4. To investigate all equipment failures and to report the findings and recommendations in a publication called "The Maintenance Metallurgical Activities Report." This publication is distributed plant wide.

5. To advise the materials and specification control metallurgist on the function of the operating equipment with which he may not be familiar, so that specifications can be made which are consistent with service requirements.

The other metallurgist is in charge of materials and specifications control. His duties are:

1. To review all orders for maintenance parts and supply the proper metallurgical specifications.

2. To keep a file record of all parts ordered as to quantity, date of order, order number, drawing number and the specification placed on each order.

3. To review specifications on drawings, which are attached to each order, and note any that are obsolete. Periodically, a list of the drawings with the up to date specifications are sent to the engineering department for revision.

4. To develop and establish new specifications to meet changing requirements as indicated by the field metallurgist.

5. To indicate to field metallurgists apparent trouble spots as determined by the frequency of orders for replacement parts.

The duties of the quality inspector are:

1. To determine compliance with specifications, by suitable methods, on all parts made in the shops and on those purchased from outside suppliers.

2. To check incoming raw materials which are stocked by the maintenance shops and identify them with a color code to denote the grade.

SPECIFICATIONS CONTROL METHODS

One of the most important functions of the maintenance metallurgical department is to make certain, by suitable control methods, that specifications placed on maintenance orders are strictly fulfilled. The simplest way in which to show how these controls are applied is to follow a typical shop order and purchase order through the plant. Although the example which will be used is for a part made from steel a similar control procedure would apply to parts made from non-ferrous materials.

Now let us assume, for example, that a shop order is placed for a mill drive pinion. Again referring to Figure 1, the maintenance planning office receives the order, enters it, and delivers it to the maintenance metallurgical department. The specifications and controls metallurgist specifies on the order the grade of steel, heat treatment and hardness desired. He records all pertinent data on the file card of the part and sends the order back to the planning office. The order analyst in the planning office routes the job through the various machining operations and to the heat treating department. When the heat treating department receives the machined pinion, which has been identified with shop order number and drawing number, the quality inspector verifies that the pinion was made from the grade of steel specified. After heat treatment, the proper checks are made to see that the specification was followed in this respect and the results are sent to the metallurgical staff for recording. If the specifications are met, the pinion is released to the mill, if not, it is held at the heat treating department for disposition by the field metallurgist in the division. At no time are the shops permitted to deviate from the specification except by proper clearance through the maintenance metallurgical department. It might be well at this time to show how controls are maintained over the materials going into maintenance parts. When ordering materials, designated by CMRO on the chart, the shops follow the specification developed by the maintenance metallurgical department. Steels which do not fall within the plant specifications may not be applied without proper clearance from the maintenance metallurgical staff.

Now let us assume that a mill places a purchase order for this same pinion. The ordering unit sends the order to the maintenance metallurgical department and here again the specification and control man records all data on the file card. He then places the appropriate specification on the order, stamps the order "Hold for Maintenance Metallurgical Testing" and sends it on to the stores department which enters it and sends it on to purchasing. When the pinion is received at the mill, from the supplier (center left on chart) the stores department holds it until the quality inspector has checked it for specification compliance. If the checks show that the specification has been met, the quality inspector notes results of the tests and releases the pinion to the mill. If it does not meet the specifications, the quality inspector notifies the field metallurgist in the division, who makes the proper disposition.

You may readily see that whether a part is made in the shops or purchased from an outside supplier, the necessary controls are applied to assure the mills that they are getting what our standards set as a satisfactory product.

ACCOMPLISHMENTS

To cite specific cases in which the maintenance metallurgical department has improved maintenance parts is outside the scope of this paper, however, many such cases could be mentioned. It is desired, however, to mention a few general accomplishments in which the maintenance metallurgical department has played a leading part. These accomplishments are:

1. Built up a card index file containing pertinent data on over 50,000 maintenance parts.

2. Increased the use of heat treated parts by several hundred per cent.

3. Improved shop practices.

4. Set up centralized heat treating department.

5. Introduced induction hardening.

6. Standardized specifications on a majority of parts.

7. Set up controls to insure specification compliance.

8. Expanded the use of chromium plating of maintenance parts.

SUMMARY

In this paper, an attempt has been made to describe a maintenance metallurgical department which has been developed at Gary Steel Works, the historical back-

ground of the organization, its functions, the methods used in controlling specification compliance, and we have cited a few of its accomplishments.

Although in the past this group has accomplished a great deal, it is recognized that there are many areas in which improvements can still be made. By expanding the application of metallurgical principles to new areas and by remaining constantly on the alert for ways in which to further improve those areas now covered, it is expected that in the future even greater accomplishments may be expected.

ANALYSIS OF FAILURES FOR STEEL MILL MAINTENANCE

By J. V. RUSSELL
Chief Metallurgist
Republic Steel Corp.
Chicago, Ill.

▲ IN this part of the symposium will be given a review of the ways in which the metallurgical department of a mill can contribute to lower maintenance cost when they work with the specification of materials and methods of making replacement parts of mill machinery. As a part of their duties, the metallurgical departments have knowledge of types of steel applied for most manufactured articles, and through contact with their customers keep abreast of current manufacturing practices. In addition there usually are laboratory facilities available to them for analysis of failures of mill parts which inevitably occur in mill operations. Such careful analysis coupled with experience in the application of materials and metallurgical principles is, in our opinion, the keystone of a successful maintenance program. This paper will cover some of the problems typical of the many encountered and give some idea of the way in which they have been solved.

We can list three types of failures and they will cover most of the problems met in the service of mill parts. They are:

1. Wear
2. Brittle fracture
3. Fatigue

Figure 1 — A chain link and pin assembly removed from a large mechanical chain shows that the pin is deeply worn and distorted. It can also be seen that the link is stretched and worn.

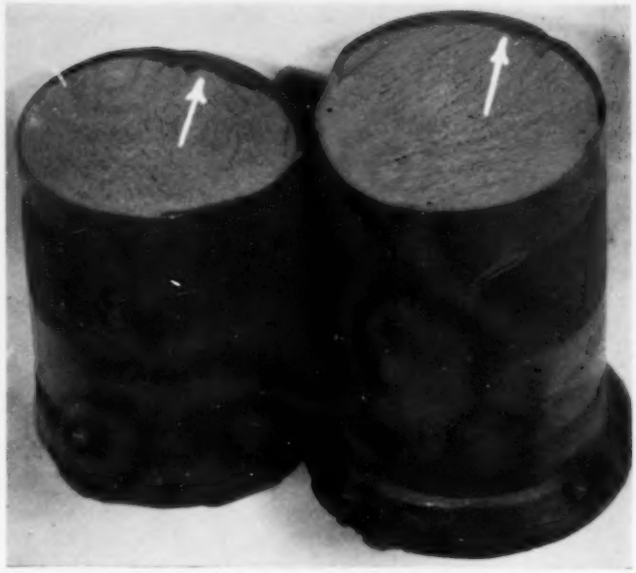


Figure 2 — Carburized and hardened alloy steel pin, made as a replacement for the above assembly, after two seasons showed wear was negligible. It was removed due to the surface crack found by ultrasonic inspection, and then broken open in the laboratory to show the crack.

Figure 3 — This link was made of alloy steel hardened to spring temper (375 BHN) to replace the original soft links. It operated for an entire season with practically no wear although it did fail due to mechanical difficulties.

Each of these is distinctive in its appearance and in his analysis, the metallurgist attempts to classify his case as one or the other of these for preventive measures are different for each. Wear is a familiar problem and although it may not be possible to prevent it, we can usually reduce its rate considerably by proper application of materials and lubrication. Brittle failure is not always recognized, but is, in our experience, next to wear as a manner of failure of mill parts. With few exceptions, it can be avoided by the use of properly heat treated alloy steel. Fatigue is a progressive failure which requires repetitive cycles of stress over a considerable period of time before failure finally results. Even when properly treated material is used, failures still can result in this way, and in that case design changes are necessary for correction of the condition. A few examples follow as illustrations of the solution of typical problems.

We consider wear to be by far the greatest cause of part failure in mill operations. The following examples will prove our point and show at the same time how it can be decreased. Figure 1 is a link assembly of a large chain and it is clear that there has been quite a lot of wear. In addition the material seems soft as indicated by distortion of both the link and the pin. Analysis re-

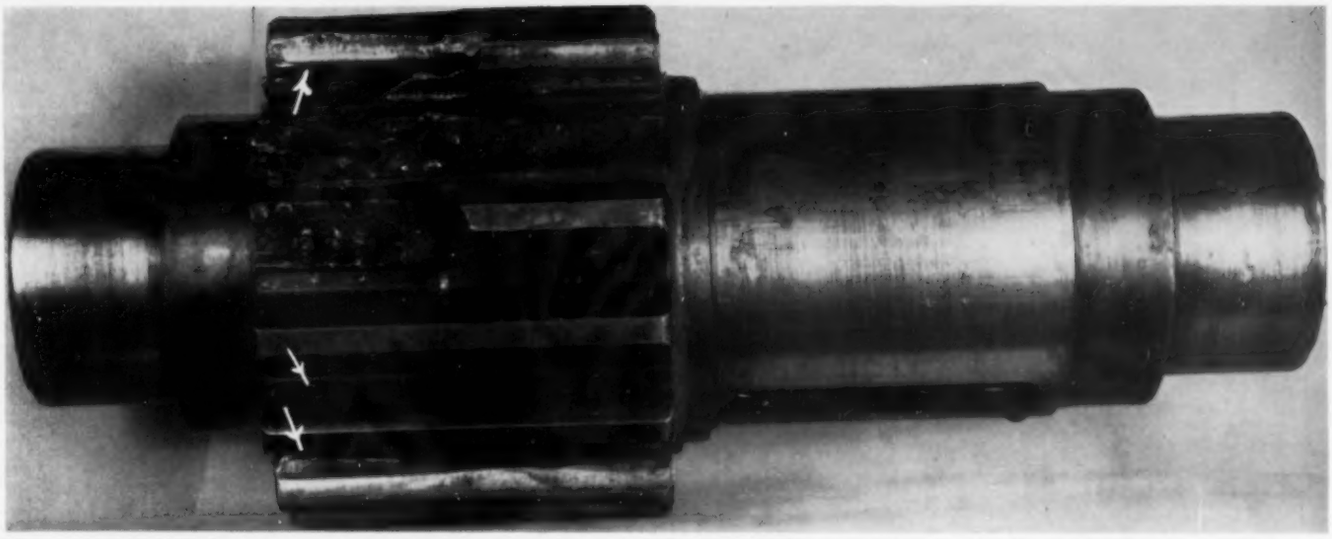


Figure 4 — This failed pinion showed heavy wear at the pitch line and below it, although the tips of the gear were file hard. The teeth failed by fracturing out at the roots.

Figure 5 — A detail of one of the failed gear teeth shows the crushing of the hard, brittle tips after failure. The inset is a cross-section of the same piece showing only the tip to have been heated and hardened. The failure was through the tooth root in the coarse as-forged structure. The pinion had been made out of C1045 steel. A carburized and hardened alloy steel pinion should have been used.

vealed that both the link and the pin had been made from C1040 steel with a hardness of only 200 Brinell. It was decided to fabricate a new chain using pins made of low carbon alloy steel carburized and hardened while the links were made of an alloy spring steel and hardened to about 400 BHN. Feeling that deflections were to be a normal condition for the links, higher hardness was not desired and some wear resistance was sacrificed. We can see the result of these recommendations in these parts removed two seasons later (Figure 2). Some pins were breaking in the chain and ultrasonic inspection found this one still intact, but with a quench crack which was the probable cause for the other failures. Slight adjustments in the quenching technique were made to prevent their recurrence. We call particular attention to the very small amount of wear which is characteristic for properly carburized and hardened parts. Although broken in the laboratory this is also an illustration of the brittle character of carburized parts when there is a crack present. An indication of its strength however is that a load of 94,000 pounds was required to break it open. A link (Figure 3) broken after a season's service is also shown to illustrate negligible wear on it also. The cause of breakage was probably due to a pin failure and the ductility of the material is apparent from the fracture appearance. This has come to be the practice for most mechanical chains which are fabricated in our plant.

Other parts in which wear is a prominent cause for failure are the many gears (Figure 4) used in all machines throughout the mill. We find that many of these larger gears are furnished as C1045 steel with no attempt having been made at hardening the teeth. Needless to say, where service is even moderately severe the rate of wear is quite rapid. In other cases some hardening has been attempted as in the case of this pinion, but without doing the gear much good. In this instance we see considerable wear at and below the pitch line although the tips of the teeth were file hard. Flame hardening evidently was attempted but only the tips were hardened (Figure 5). The result was a gear of very low strength. A carburized and hardened alloy steel pinion was the recommended replacement. Whenever gears are hardened, whether by carburizing, induction, or flame hardening, it is essential that the entire tooth surface and tooth root be hardened or else fatigue or brittle fractures will develop in the tooth roots.

This leads directly into our second category of brittle fracture which occurs suddenly with little or no previous warning. We are prone to associate such failures with hard steel, but they are by no means so confined. Indeed, under certain conditions soft steel such as

Figure 6 — A 15-ton auxiliary hoist hook failed when it caught in the main hoist equalizer which was lowering a ladle. The fracture fits together to show virtually no distortion of the hook during failure, so that we may class it as a brittle fracture.

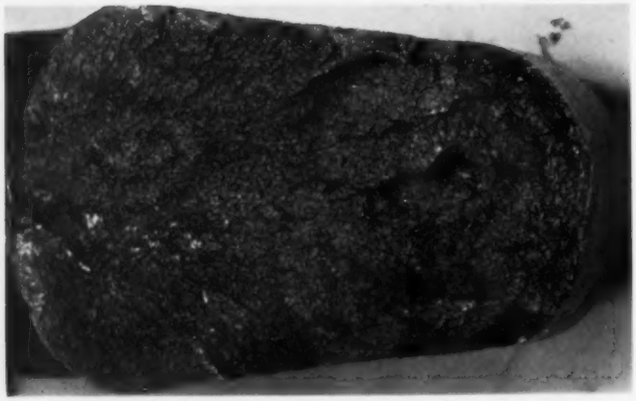


Figure 7 — The fracture surface of the failed hook shows the characteristic crystalline surface of a brittle fracture. The material is C1020 with a hardness of 103 BHN.

C1020 or C1040 is quite likely to fail in this way and we have seen many examples of such failures in soft material. We wish to make a special point of this as we have observed a tendency on the part of engineers, where ductility is desired with strength a secondary consideration, to think such steel on the basis of published mechanical properties quite satisfactory. An example of such a failure is this large crane hook (Figure 6) which showed a relatively brittle fracture (Figure 7). The material is C1020 which had been normalized with a hardness of only 103 Brinell and yet a brittle fracture resulted when it was accidentally overloaded. Examination shows a characteristic crystalline fracture surface with no defects. Mechanical properties on this part were as follows:

Yield strength	Tensile strength	Per cent elongation
31,000 psi	60,000 psi	33.5

Per cent reduction in area	Izod	Hardness
59.6	16	103 BHN

Part of the reasoning behind the use of soft materials for crane hooks is the desire for the hook to distort out of shape instead of breaking under an overload. Instead of this ideal we have observed that due to the shape of the hook and the nature of the material, brittle failures are the rule.

In the time we have been associated with the many men of many different skills charged with the responsibility for keeping the mill going we have known none quite like the welder. His self confidence is unbounded. There is no repair he will not attempt with a burning torch and welding rod, and if machining may take a few days he is certain to jump in the breech with his torch and complete many day's work in a few seconds. Unfortunately though, the job may not last long enough to get another spare ready. An example of burning in the wrong place is this 15-in. I-beam (Figure 8) used to lift the roof to a top charge electric furnace. It failed in a brittle fashion and we found that bolt holes had been burnt out. The hard skin formed around this hole during burning was sufficient to set off brittle failure of the beam. Structural steels may be welded but great care in design of weldments is necessary if failures are to be avoided.

Last on our list of failures in which choice of material

Figure 8 — A 15-in. I-beam failed at holes burnt out for assembly. The texture of the brittle fracture points to the holes as the point of origin.

Figure 9 — Fatigue fracture of an axle shaft of alloy steel, to which a bearing retainer had been tack welded, originated at one of the tack welds shown by the arrow.

Figure 10 — Section, through the shaft and the retainer, shows the hardened area below the tack weld and the fatigue crack which it originated.

and its treatment are involved are fatigue failures. This is advised since responsibility for such failures is usually divided between the metallurgist and the engineer. It is our feeling that the metallurgist recognizes his responsibility only when he sees it through his microscope and that the engineer only finds his in the list of revisions and Mark's handbook. There is a lot of territory between these extremes and it is there that the two must meet if they are to furnish any really good answers. One or two illustrations can show this, we believe.

There are times, however, when the engineer and welder team up with disastrous results along this line. Figure 9 shows a section of a large axle which had failed in fatigue. The markings of fatigue passed the center before failure so that stresses were not exceptionally severe relative to the strength of the material. The material was heat treated alloy steel but it appeared

Figure 11 — On straightener drive shaft, after a relatively small fatigue development, there was a brittle failure. This indicates a stress high relative to the strength of the material which was hot rolled C1045. The part lasted only one month.

Figure 12 — The drive shaft for which the one previously shown was a replacement was made of heat treated alloy steel and lasted for five years. It failed with a tough fracture after a slowly developed fatigue.

that a bearing retainer had been tack welded to the shaft (Figure 10) and it was at this tack weld that the failure had originated. Examination of the print showed that the method was actually specified for the part. A spacer of conventional design was substituted without any weld being necessary and the part has given no trouble since.

An example of unsuitable material is this straightener (Figure 11) drive shaft made in our shop from hot rolled C1045 steel. It operated only for one month and then failed in a brittle fashion. Fatigue had started, but the material quickly failed in a brittle fashion. Actually the shaft was a substitute for an alloy steel

shaft which previously had operated for about five years. Failure in the alloy shaft was almost identical (Figure 12) except that failure progressed very slowly through the cross section before ultimate failure. In comparing these two parts, we find one material very weak and brittle which failed with two thirds of the section intact. The metallurgist admits the material leaves something to be desired and the engineer agrees with him. In the other case, failure is slow and less than half the remaining cross section supported the normal load. At this point, the metallurgist feels he has done his best and the engineer must consider the part design to reduce stress concentrations not indicated by static loads if longer service is to be attained. There are, as we have said, many cases where a proper answer lies between these two extremes, and close co-operation of the metallurgist and the engineer is the real answer to our problem of getting more operating hours for our maintenance dollar.

In discussing fatigue failures it must be conceded that they all cannot be avoided. On this account the metallurgical department can often advise and carry out non-destructive tests to detect such failures and to suggest procedures for repair or replacement before actual failures. Where such failures are suspected as likely or where it is critical that any defect be detected such inspection is used by us. Particular parts are usually selected and watched carefully, but a "whole hog" program does not appear desirable to us due to the expense of such inspection.

This paper has outlined the principal types of failure and shown what the metallurgist can do to prevent them. Wear and brittle failures can usually be minimized by choice of proper materials and suitable treatment. Fatigue failures are more complicated sometimes requiring design changes and sometimes being caused by improper choice of material or its treatment. In all these cases, however, we feel that the metallurgical department has real service to offer the engineer not only in analysis of failures, but in the choice of materials and treatment of parts at the time of their original design.

METALLURGICAL ANALYSIS — A TOOL

By M. E. OLSON

Superintendent, Mechanical Maintenance

Youngstown Sheet & Tube Co.

East Chicago, Ind.

▲ AS industry turns to automation in its manufacturing processes, maintenance becomes a more important part of the cost of operation. Individual pieces of equipment are dependent on others in a continuous manufacturing process so that the failure of one piece of equipment can stop a whole series of operations, with the resulting loss of product and increased cost of maintenance.

Industries today are in the process of reducing emergency or breakdown maintenance and improving on their preventive maintenance programs. To do this effectively, the maintenance department must have a repair record on each piece of equipment. This record must give, among other things, the cost of repairs, frequency of repairs, and the effect of these repairs on production. This is of utmost importance and will point out those places where improvements are needed and justified.

In the evaluation of this equipment repair record, the metallurgical department can be used as an effective maintenance tool.

One of the most important factors is the possibility of improved design of the component parts of the equipment. Many times a part develops a record of continued failures long before the expiration of its expected life. The metallurgical department, after making a study of the part, can make recommendations as to the procedure to follow in order to avoid a similar failure in the future. It may be that there was a hidden fault in the material. Possibly the heat treatment of the material was at fault—making the part too hard or too soft. The design of the piece may be the answer; too sudden a change in cross-sectional area without the proper compensating fillets. The finish of the part may be the answer; or damage to the finish due to careless workmanship in assembly. All of these things can be determined by metallurgical analysis of the broken parts.

A maintenance metallurgy department is certainly an excellent organization which no doubt is of considerable help to the maintenance department. Some of the smaller companies may feel that the volume of maintenance work is not sufficient to justify the employment of specialists on a full time basis, but regardless of the size of the company it is desirable to have close co-operation between the maintenance and metallurgy departments. Where there is no maintenance metallurgy unit, it is the maintenance departments responsibility to see that the metallurgy department is kept informed of their problems so that the metallurgist can take an active part in reducing maintenance costs. This requires that maintenance foremen be educated to the importance of the metallurgical department in helping him with his problems.

To help the foreman in keeping the metallurgy department informed, we have developed a "Request for Metallurgical Investigation" form. This form is divided into three sections. The first section is filled in by the maintenance foreman, and gives the following information: name of the equipment, assembly and detail drawing numbers, name of the part, whether it is original equipment, purchased equipment or made in our own shops, a sketch of the part that failed, any other pertinent remarks and by whom requested. The second section is filled in by the metallurgical laboratory, and states the results of the investigation. The third section is used for recommendations by the metallurgical laboratory. This form is made out in duplicate, put in a water-proof envelope and wired to the part to be sent to the laboratory for analysis. After analysis one copy is retained by the laboratory and the other returned to the maintenance foreman.

Some examples of the results of these metallurgical tests may better illustrate the continued need for these tests. The kickoff paddles on one of our continuous butt weld pipe mills were causing considerable trouble

due to breakage and wear. These paddles consisted of a mild steel spade welded to a mild steel stud. The spade end was hit by the pipe and pivoted enough to operate a switch. These paddles operated about 2000 times per hour, 24 hours per day, and had to be strong, light, able to withstand heat and have good wearing qualities. Breakage usually occurred in the stud which connected the spade end to the switch shaft. This, and wear on the end of the spade, were the most frequent causes of trouble. Hard surfacing of the spade was tried and other ideas were tried without too much success. The metallurgy department was informed of our problem and they recommended a one piece paddle forged from a high carbon alloy steel and given a differential heat treatment to give good wearing qualities to the spade and strength of shaft in impact. This one piece paddle has solved the problem by giving long periods of continuous service.

Another example is that of the forming and welding mill spindles in the same mill. We were experiencing difficulty with spindles bending or breaking. These spindles were forged from a good alloy steel, but the heat treatment was critical and it was difficult to make them the proper toughness and yet not so hard that they lost their elasticity. The metallurgical department recommended that we use hot rolled bars of 4140 steel, normalized at 1625 F before machining. After machining, the spindles were to be hardened by heating to 1600 F and quenched in oil. The final operation was to give them a draw for four hours at 800 F. This new steel and the described treatment have eliminated the trouble. Not only were delays reduced, but the cost of making the spindles using hot rolled steel was less expensive than using forgings.

Another example is the analysis of the causes of the failure of a crane hook in the continuous pickler. This hook was carrying a heavy coil weighing approximately 20,000 lb when the failure occurred. The hook broke on the side with a sharp crystalline fracture indicating a noticeable lack of ductility. This hook had been purchased and was a 10-ton capacity hook. After analysis, the metallurgical laboratory found that the hook was made of 1035 or 1040 steel, that the hook failed due to a suddenly applied load such that the failure was due to shock or sudden impact. The rather low strength, coarse structure, and cold working of the inner surface where the hook is under tension were contributory factors. Proper heat treatment or normalizing of the hook after forging would have been helpful in preventing failure. Their recommendation was that we use an 8640 alloy steel in the future, and in order to insure grain refinement after forging, the hook should be normalized at 1650 F and drawn at 1050 F. These recommendations should result in elimination of other failures such as this which could be the cause of serious injury to workmen and/or extensive damage to equipment.

Another factor in the evaluation of the equipment record is the possible use of improved materials in cases where erosion or corrosion is a problem. It has been generally agreed that the direct cost of corrosion to the American industry is several billion dollars annually. And even greater costs may be involved in the hidden cost—the production lost when equipment must be repaired and replaced because of corrosion.

Probably the answer to industrial corrosion problems is to assign special personnel to corrosion engineering work. This could probably be handled very capably by the metallurgy department. This type of work would involve selection of materials, investigation of failures on high-maintenance items, the setting up of specifications for materials, procedures, heat treatment, etc., for new or repaired equipment.

Another important phase of a good preventive maintenance program is inspection. The results of proper inspection are that small jobs can be done to prevent unnecessary delays. Most of the inspection that is done is of the visual type. This allows us to find loose bolts, worn bushings and gears, misalinement of shafts and various other things that can be corrected. However there are other types of defects that are not visible which may cause much more serious damage to equipment when they cause failures. Here is a place where our metallurgical departments can be of tremendous help.

By using such instruments as the ultrasonic tester, and magnetic flux methods we are able to detect fatigue cracks that are just starting. This method has proven most successful in locating these defects. An excellent example of the use of these testing devices is that of a crankshaft on a blooming mill steam engine at the Cleveland plant of the Republic Steel Corporation. If this crankshaft had failed, it could have caused considerable damage to buildings and equipment, and even loss of life. The loss of production could have lasted for a period of weeks. However, the ultrasonic tester revealed that cracks were appearing in one of the crank pins. The engine was kept in operation and with periodic testing they were able to determine when the critical period had arrived. At this time the engine was shut down for two days and a new crankshaft was installed. This testing eliminated a most costly breakdown. It also saved the old crankshaft because they were able to send it back to the manufacturer for replacement of the cracked crankpin.

Another example of the success of this method of testing occurred in our Indian Harbor Plant. We experienced trouble on a table drive on our five-stand cold mill. Visual inspection showed that parts of several teeth were broken out of a herringbone gear. The gear case was cleaned out, but before the drive was reassembled it was decided to make a magnetic flux test of the gear. This test revealed that another part of a tooth was cracked and about to fall out. This tooth was removed and the drive was reassembled. This drive is still giving good service because the defect was discovered in time to prevent further damage.

A new type of testing instrument has recently been placed on the market. This tester is called the permanent magnetic flux yoke. The manufacturer of this instrument claims that fatigue cracks, stress cracks, cracks out of rivet holes, surface cracks in welds, corrosion cracking and bending cracks in magnetic materials all can be shown quickly and positively. The instrument is 100 per cent portable since the entire kit weighs but 22 lb. There are no cables because the power for operation comes from a permanent magnet. This feature allows it to be used in areas where arcing must be avoided.

To make the most effective use of preventive maintenance, it is important that all personnel connected with maintenance be given the basic fundamentals of

the heat treatment, physical properties, etc., of the different grades of steels. With the increased use of alloy steel bolts and studs, it is important from a safety as well as maintenance viewpoint that maintenance men understand that one piece of steel is not necessarily as good as another piece which looks the same. The substitution of standard bolt from stock, for an alloy bolt, may result in the failure of a piece of equipment and possible injury to personnel.

Almost every person connected with maintenance can recall many instances when the metallurgy department has been used, or could have been used to great advantage. The more frequent use of the metallurgical facilities at hand will materially help to solve maintenance problems.

DISCUSSION

PRESENTED BY

T. J. PETERS, Director of Maintenance and Construction, Acme Steel Co., Chicago, Ill.

R. H. DAVIS, Maintenance Metallurgist, Gary Steel Works, United States Steel Corp., Gary, Ind.

J. V. RUSSELL, Chief Metallurgist, Republic Steel Corp., Chicago, Ill.

S. S. CALLNER, Partner, S. S. Callner & Co., Chicago, Ill.

L. A. TERRY, Superintendent Power & Electrical Dept., National Tube Div., United States Steel Corp., Gary, Ind.

T. J. Peters: Will you discuss nitriding of wearing parts?

R. H. Davis: We do not have facilities at our plant for performing this work; consequently, most of our wearing parts are carburized and hardened. Nitriding, however, does offer certain advantages over carburizing. Probably the outstanding advantage of nitriding is high surface hardness and wear resistance. The surface hardness of a nitrided part will approach a Vickers hardness of 1200 as compared to 700 to 800 for one that has been carburized and hardened. Other advantages are its resistance to certain corrosive media (mineral acids excepted) and to softening at elevated temperatures (750 F to 900 F). Also, no subsequent heat treatment is required as in the case of carburizing. Nitriding is not without its disadvantages, however. It is a much more costly process because, in the first place, special alloy steels are necessary if optimum properties are desired and, secondly, nitriding equipment is expensive. Depending upon the quantity, nitriding has been variously estimated to cost from 5 to 10 times more than carburizing and hardening.

J. V. Russell: One of our metallurgists in another district developed a starter show on a scarfing torch which rides on the billet. This part was nitrided and worked out very successfully. We do not have equipment to do this work and find that we can get work carburized more readily than nitrided.

S. S. Callner: I would like to hear a discussion on the following three items: metallizing, hard facing alloys and brazing.

J. V. Russell: One of the best applications of metallizing that I have seen was on a diesel engine crankshaft. The journals were worn down and sent out to be built up. The shaft broke shortly thereafter in a fatigue failure and we found that in order to make the metal stick, they had scored the journal with about a No. 10 machine screw thread. So my attitude on metallizing is that if you want so much metal there and you can make it stick, there is no particular objection to it. Hard facing alloys, of course, are used widely in many applications. Hard facing is used extensively on table rolls, especially table rolls close to the mill, such as the blooming mill. The first two or three rolls will have strips of alloy faced across them. Stripper tongs or soaking pit tongs all are almost universally hard faced and certainly are good applications and probably the best way of doing the job. As for brazing, I have never seen a part of any consequence brazed except for some iron castings.

R. H. Davis: We have found metallizing useful in building up armature shafts in our electric shop and in applications where parts are exposed to certain corrosive atmospheres. As to brazing, I assume that Mr. Callner is referring to brazing high speed steel cutting tools to carbon steel shanks. This is done quite extensively at our plant.

L. A. Terry: What do you do about wearing out of crane wheels?

R. H. Davis: Carburized and hardened crane wheels are doing a good job at our plant, particularly where flange wear is a problem. There is, however, one word of caution which should be mentioned. When wheel loads are high, a steel should be used that will develop sufficiently high core properties to support the hard, brittle carburized case. If this is not done, shelling of the case is likely to occur.

There is a demand for copies of the following Yearly Proceedings:

1936 1937 1938

1944 1952

If your copies are not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

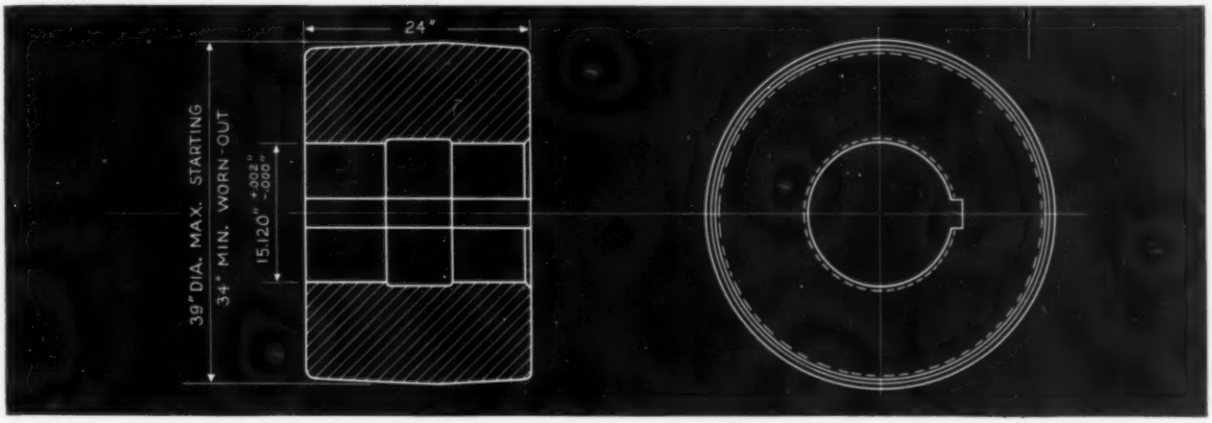
TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

THE SECRET OF GOOD TUBE MILL RINGS:

Put the extra metal where it does the least harm



Any roll ring cast with a cored hole creates special problems. Tube mill piercing rolls are no exception.

General foundry practice has been to allow sufficient stock on both the outside diameter and bore to permit "giving a little and taking a little" to "true" the finished O. D. with the I. D. when machining. Mack-Hemp foundrymen have modified this practice by keeping the outside stock at a minimum and increasing the stock in the bore. This extra stock in the bore provides an ample margin for "truing up" the two diameters during finishing, with only a bare minimum of metal removed from the O. D.

The roll user benefits in two ways—better rings at a lower price. In the first place, with roll rings priced as they are, on a "cent-per-pound-on-rough-weight" basis, he saves money. This is because extra metal near the center of the roll weighs far less than the same thickness at the roll surface. For instance, every ¼" of oversize on the O. D. of a 39" diameter, 24" long ring adds roughly 110 pounds of metal. On the other hand, ¼" extra stock on the 15" bore of the same ring adds only 40 pounds.

The segregation problem—Even more important, however, is the improvement in the depth of sound metal below the surface of the cast roll which is gained by casting to minimum tolerances on the O. D. and maximum on the I. D. Mack-Hemp tube mill rolls are noted for their freedom from the "segregated streaks" which lead to scrapping before worn-out diameter. Since these flaws usually occur at a fairly regular depth below the outside surface of a cast roll, the closer the O. D. as-cast diameter is to the finished diameter, the deeper this zone of segregation.

The relation of "bite" to hardness and wear—A very important requisite of a piercing mill roll is good "bite" to eliminate slippage. Ideally, this should be achieved without sacrificing too much wear resistance. Fortunately, bite and wear resistance are not always in direct proportion to hardness. Both these qualities can be combined—at least to a degree—in the same roll. For example, a roll of one alloy type may slip more than a harder roll of another type. Today, higher speed mills have stepped up the demand for these better, harder rolls.

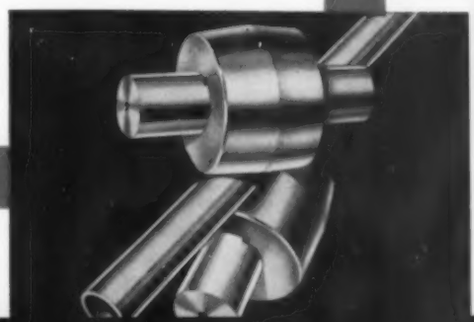
Mack-Hemp's broad experience with the many tube mills now in operation can be of real help to any tube mill operator with a roll problem. And it's the same story no matter what your type of mill. For help with any problem of roll use, call on Mackintosh-Hemphill Division, E. W. Bliss Company, 901 Bingham Street, Pittsburgh 3, Pennsylvania.

MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery



"By installing Fusetron Fuses . . .

We saved from $165 to $225 worth of solenoid coils a year and reduced down-periods"

ED. O'HATNICK, CHIEF ELECTRICIAN
FRANK KNEELAND PLANT, UNITED ENGINEERING & FOUNDRY CO.
PITTSBURGH, PA.

Mr. O'Hatnick continues . . . "The solenoids on the hydraulic clutches of our horizontal boring mills would sometimes stick or slow down when dirt got into the oil.

"When this happened, the tap D. C. solenoid coils wouldn't be pulled in far enough so they would burn up.

"Each coil cost about $15 and with 12 to 18 of them burning up every year it didn't take long for this to add to a considerable amount of money.

"And even more costly were the production losses that resulted from these shutdowns.

"With hope of reducing these expenses, we decided to individually protect the 72 solenoids in use with 3/10 ampere Fusetron dual-element fuses.

"In the next 3 years only 2 coils burned up.

"We had other favorable experiences with Fusetron fuses that convinced me they can make a plant more effective.

"That's why, upon being transferred to our Frank Kneeland Plant, I made a study to see where Fusetron fuses can be applied to help us reduce operating costs."

357

Here's why Fusetron dual-element Fuses protect solenoids, coils and transformers against burnout.

By installing the proper size Fusetron dual-element fuse, a solenoid can be protected. The Fusetron fuse will not open on the operating surge but will open in time to protect, should the heavy current continue too long for any reason.

A transformer or coil, likewise, can be protected because the long time-lag of the Fusetron fuse permits it to hold all normal current surges and harmless overloads—yet it will open to prevent burnout on any dangerous overload.

All you need to protect Coils, Transformers or Solenoids against burnout is a Fusetron fuse plus a fuse block or a BUSS fuse holder.

On voltages up to 125 the same dependable protection can be provided with a proper size Fusetron plug fuse or BUSS Fustat.

FUSETRON FUSES DO MORE THAN PROTECT SOLENOIDS AGAINST BURNOUT . . . ***They Provide 10 Point Protection*** **1.** High interrupting capacity — protect against heaviest short circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes. **2.** Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation. **3.** Protect against needless blows caused by harmless overloads. **4.** Provide thermal protection — for panels and switches against damage from heating due to poor contact. **5.** Protect against waste of space and money — permit use of proper size switches and panels. **6.** Protect motors against burnout from overloads. **7.** Give DOUBLE burnout protection to large motors — without extra cost. **8.** Protect motors against burnout due to single phasing. **9.** Make protection of small motors simple and inexpensive. **10.** Protect coils, transformers and solenoids against burnout.

Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS . . . USE BUSS HI-CAP FUSES! When coordinated with Fusetron fuses they will not open ahead of the fuse nearest fault.

Write for bulletin HCS.

Play Safe! *install FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!*

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN MFG. CO. *Div. of McGraw-Edison Co.*
University at Jefferson, St. Louis 7, Mo.

8 good reasons why you should use these ROLLER GUIDES in your bar or wire rod mill

Nos. 125 and 155 roller guides fitted in a 27 1/2 in. (700 mm.) diameter, three-high stand for rolling 2 3/4, 3 3/16, 3 9/16, 4, 4 3/8 and 4 7/8 in. (70, 80, 90, 100, 110 and 124 mm.).

1 The entry friction guides are rigidly clamped into the guide box. They are intended to lead the oval to the groove in the roller, to protect the rollers against overloading, and to straighten bent rods.
The groove in the entry guides is made about 1/8" wider than the oval.

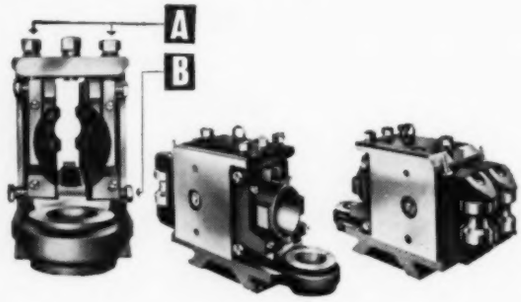
2 The rollers are mounted on leaf springs, which can be adjusted by means of the screws "B", and hold the oval steadily even if there should be some slight variation in the thickness of the oval.

3 If the thickness of the oval should vary, the springs of both rollers yield an equal amount, so that the oval remains in the centre of the groove.

4 To tilt the oval, the screws "A" are adjusted. One roller will then be lifted as much as the other is lowered.

5 As the oval is held very rigidly, the leader oval for wire rod may be thick, unless other circumstances call for a thinner oval.

6 The roller guide assemblies are narrow, and all screws that require adjustment during rolling are accessible from the front of the mill. No lateral space outside the guide box is therefore required for gaining access to the set screws, and the guide box assembly can thus be located close to the mill housing.



7 As the groove in the entry guides is wide and nothing but rolling friction acts on the oval, the latter is very easily introduced into the pass, and there is practically no risk of scratching the bar.

8 The roller guide may be used not only for leader and drawing oval passes but also for edging flats as well as for rolling squares, hexagons, octagons and various other sections, for instance in reduction passes for hexagon. It is suitable for all types of rolling mill. An important advantage is that the roller guide enables repeaters to be used in rolling plump leader-ovals.

PS *Practically speaking, every bar and wire rod mill in Scandinavia uses roller guides of our design.*

MH **MORGÅRDSHAMMAR**

MORGÅRDSHAMMARS MEK VERKSTADS AB • MORGÅRDSHAMMAR • SWEDEN

Telegrams: Morgårdshammar, Ludvika. Sweden

SOLE AGENT FOR THE US:
K.W. Atwater Engineering, Inc.
401-03 Butler Street
Pittsburgh 23, P.A.

TORRINGTON *SPHERICAL ROLLER* BEARINGS

This bearing can take thrust, too!

Design is the secret. TORRINGTON Spherical Roller Bearings are made with an integral center flange on the inner race. This assures *positive radial stability and accurate positioning of rollers* wherever high radial load and heavy thrust are encountered under conditions of misalignment.

From crushers to cranes, power shovels to pulverizers, you get long, maintenance-free operation, better performance in your equipment, more value from your bearing dollar when you specify these rugged dependable bearings.

Prove to yourself that TORRINGTON design does make a difference. Next time specify TORRINGTON Spherical Roller Bearings. They're available with either straight or tapered bore, for shaft or adapter mounting.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District offices and distributors in principal cities of United States and Canada

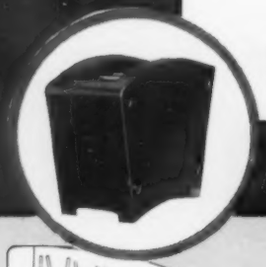
TORRINGTON BEARINGS
Spherical Roller • Tapered Roller • Cylindrical Roller
Needle • Ball • Needle Rollers

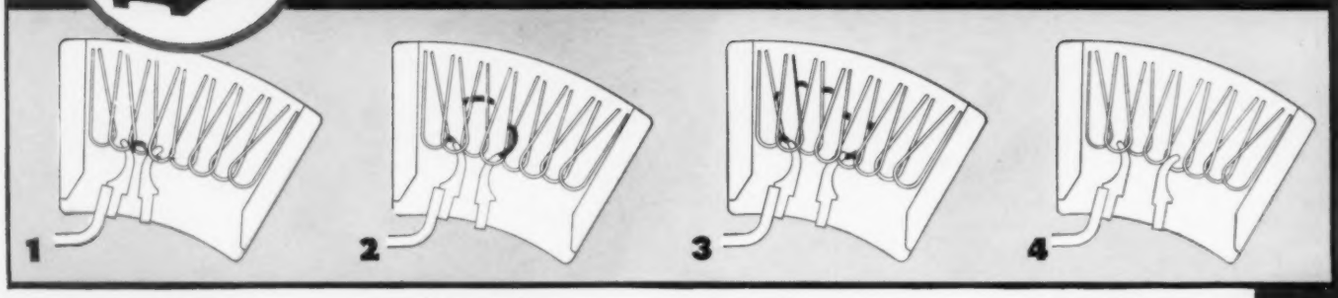
for fast arc interruption... without blowout coils

ALLIS-CHALMERS

TYPE 425 CONTROL

featuring *ACBO* arc-centering blowout chutes for 50 to 400 hp



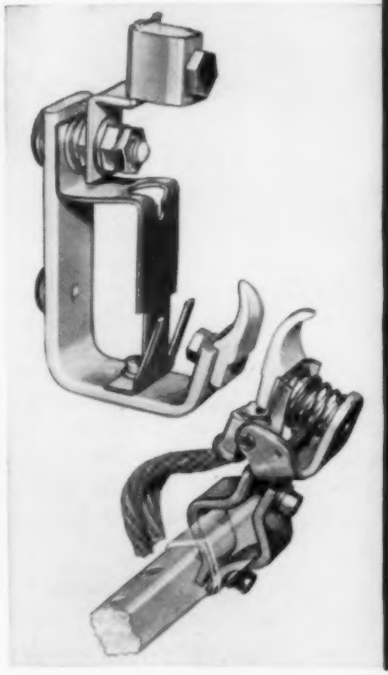


1 — Arc across contacts as they start to open.

2 — Strong blowout action forces arc to center.

3 — Arc rupturing.

4 — Contacts fully open — arc extinguished.



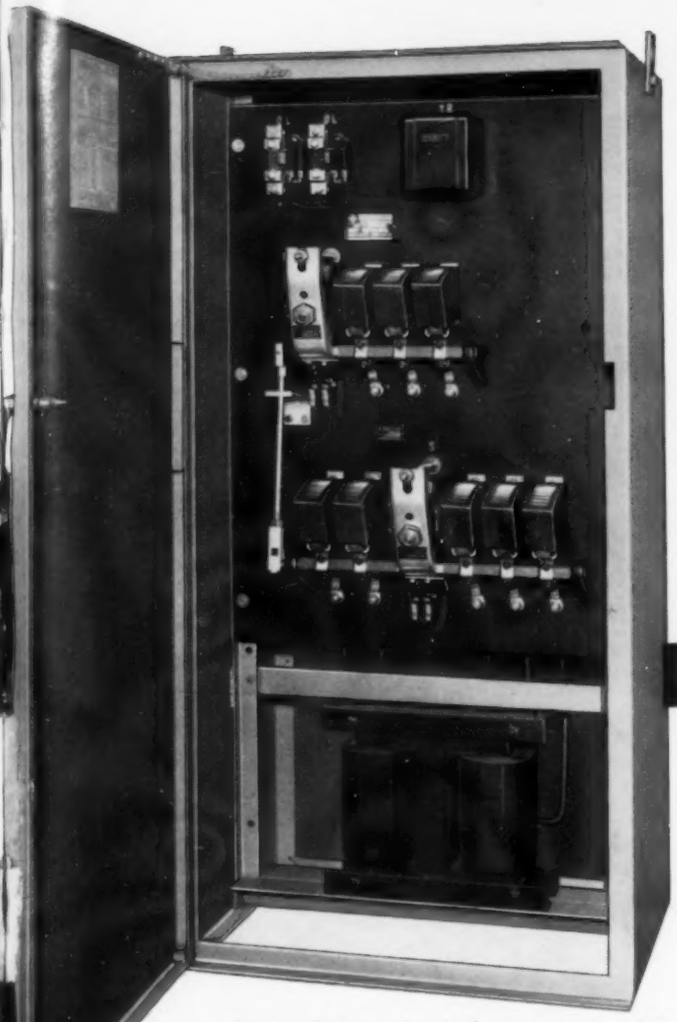
Advanced electrical design

Allis-Chalmers Sizes 4, 5 and 6 Type 425 starters and contactors incorporate the *ACBO* arc chute for much longer contact and chute life . . . for maximum contactor efficiency . . . for improved performance. This unique but simple device utilizes the principles of magnetic action and thermal convection to center, rupture and extinguish the arc — *quickly* . . . without the use of conventional blowout coils.

Simplified mechanical design

- Streamlined clapper-type construction eliminates many parts — permits natural arc rise in arc chute.
- Accessibility simplifies inspection and maintenance.
- Installation is fast and easy. Ample wiring space is provided by *sensible* enclosure dimensions . . . by well-placed concentric knockouts, terminal lugs and conduit hubs. Terminals are clearly marked.

ALLIS-



Autotransformer reduced-voltage starter in NEMA 1 enclosure with 3 and 5-pole Size 4 contactor.

A type for any application

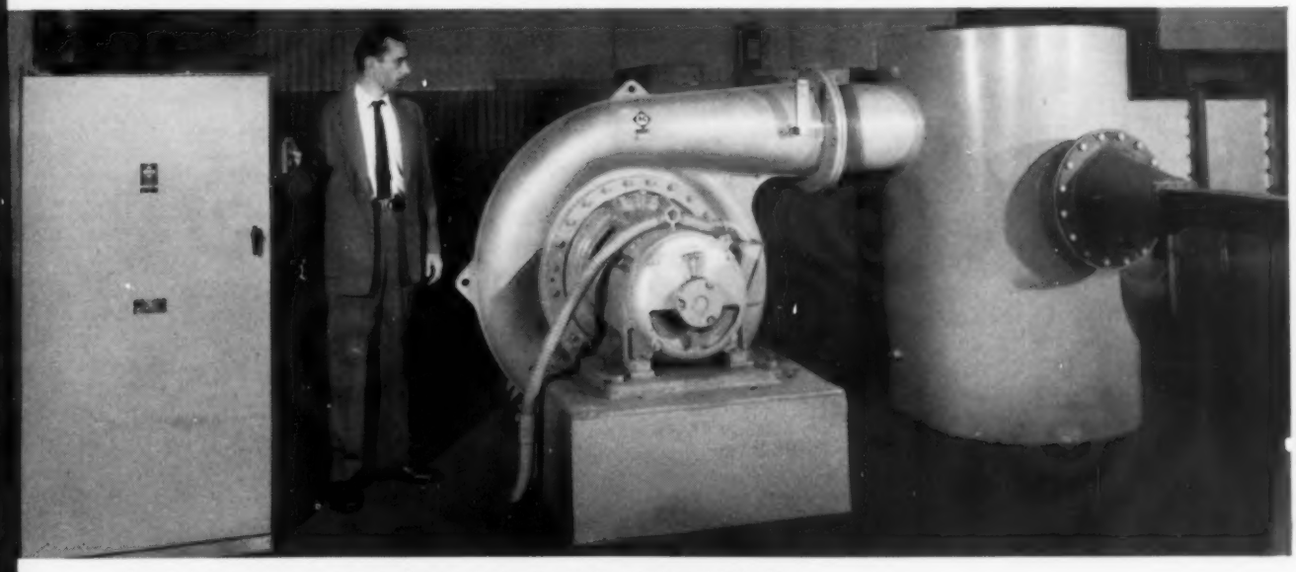
- Across-the-line general purpose starter
- Combination starter with disconnect switch
- Combination starter with circuit breaker
- Reversing starter
- Multi-speed starter
- Autotransformer reduced-voltage starter
- Primary reduced-voltage starter
- Magnetic increment-type starter (part winding)
- Magnetic star-delta starter
- Wound-rotor motor starter
- Synchronous motor starter
- Low voltage group control
- Ac magnetic contactor

Modifications available for applications requiring special features or design.

Engineering help

Allis-Chalmers offers expert engineering and application advice. Product specialists, industry application experts, modern laboratory and testing facilities . . . are all available for coordinated effort to help solve your control problems.

For detailed information on Type 425 control, call your A-C Control Distributor or your local A-C District Office . . . or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis. Ask for Bulletin 14B8615.



Size 4, reduced-voltage autotransformer starter for 50-hp, 3550-rpm induction motor driving turbo-blower. Motor and blower also built by Allis-Chalmers.

ACBO is an Allis-Chalmers trademark.

CHALMERS

A-C ALLIS-CHALMERS

A-5342

Mill scale removal by Dowell started this new plant off with a $100,000 operating profit

Here's how the management of a multi-million dollar corporation used its knowledge of chemical cleaning to start a new plant off in the right way—in the black.

Following construction, and before the plant was put on stream, Dowell was called in to remove mill scale from the following systems:

• Ammonia Compressors Suction and Discharge Piping • Engine Water-Cooling System • Engine Oil-Cooling System • Engine Jackets • Hydraulic Oil-Cooling System • Oxygen Suction and Discharge Piping • Miscellaneous Piping • Product Lines to Storage • Miscellaneous Towers

The total cost of this mill scaling was approximately $5,000. But, once in production, this plant did not have a single major shut down for maintenance caused by mill scale. The plant management credits Dowell Service with netting the plant an operating profit somewhere between 10 and 20 times the cost of the chemical cleaning. This amounted to between $50,000 and $100,000 the first year.

This particular case history is about a chemical company, but Dowell has startling performance data to show you—from your own industry. That's because chemical cleaning is so versatile. Dowell engineers are experts in removing scale and sludge from process systems, tanks and piping. They apply solvents in various ways—such as filling, jetting, cascading. Dowell furnishes all the necessary chemicals, trained personnel, pumping and control equipment.

For specific information on how chemical cleaning can help you to greater profits, call the Dowell office near you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

have Dowell clean it chemically **DOWELL**

A SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

March 1

▲ Sharon Steel Co. annual report shows net sales for 1956 of $180,044,408, net income $6,905,530, net income per share $6.28 compared with 1955 figures at $173,095,949, $7,987,622, and $7.26.

▲ Shareholders of Sharon Steel, at its annual meeting on March 26, will be asked to approve an increase in the authorized debt to $50,000,000 from the present $30,000,000 limit.

▲ The annual report for the Lukens Steel Co. shows net sales for 1956 of $105,173,925, net profit $7,504,889, earnings per share $7.87, compared with 1955 sales at $82,419,146, net profit $2,571,012, earnings per share $2.69.

▲ Bethlehem Steel Co. representatives visited Phoenix-Rheinrohr, A.F., Dusseldorf, Germany, for the purpose of discussing future joint development of natural resources and a program for technical consultation.

▲ Shipments of iron and steel castings during December, 1956, amounted to 1,344,070 short tons compared with 1,422,403 short tons in November, 1956, and 1,518,668 short tons in December, 1955.

▲ Eugene G. Grace, chairman Bethlehem Steel Co., announced that the company's $300,000,000 expansion will be about completed at the end of 1957.

▲ F. W. Dodge Corp. reported contracts for future construction in the United States totalled $2,299,554,000 in January, up 4 per cent over January, 1956; the increase in the 11 western states was 13 per cent over January last year, the increase in the 37 states east of the Rockies was only one per cent for this period.

▲ Shareholders of the A. M. Byers Co. will be requested, at a special meeting May 7, 1957, to vote on a proposed recapitalization program which includes a new class of 100,000 shares of cumulative preference stock on a parity with existing preferred stock, an increase in the authorized common stock and a split of each existing share of no par common stock into three shares of $3 par common stock; an increase in the authorized outstanding indebtedness of the company to $15,000,000.

▲ Crude-steel production during 1956 in Europe, including USSR, rose 7 per cent to 149,000,000 metric tons compared to 139,000,000 in 1955 as reported by the Quarterly Bulletin of Steel Statistics, United States Economic Commission. USSR produced 48,600,000 tons, up 7 per cent; Federal Republic of Germany 23,200,000 tons, up 9 per cent; United Kingdom 21,000,000 tons, up 4 per cent; France 13,400,000 tons, up 6 per cent; Belgium 6,400,000 tons, up 8 per cent; Italy 5,900,000 tons, up 10 per cent; Poland 5,000,000, up 13 per cent; Czechoslovakia 4,900,000, up 10 per cent; Luxenbourg 3,500,000, up 7 per cent; Saar 3,400,000, up 7 per cent; Eastern Zone of Germany 2,800,000, up 10 per cent; Sweden 2,400,000, up 13 per cent; and Austria 2,100,000, up 12 per cent. Production of pig iron increased 7 per cent.

▲ R. L. Gray, president Armco, announced the company's plan to spend $50,000,000 for expansion of the Ashland and Houston mills to increase capacity by 750,000 tons to 7,000,000 tons by mid-1959.

March 4

▲ The Colorado Fuel and Iron Corp. reported for the quarter ended Dec. 31, net earnings for 1956 of $3,646,170 or $1.04 per share, compared with 1955 figures of $4,075,842 or $1.27 per share.

▲ The AISI reports that the operating rate of the steel industry for the week of March 4 is scheduled at 94.9 per cent of capacity. This is equivalent to 2,429,000 tons compared with 2,456,000 tons one week ago and 2,462,000 tons one year ago. Index of production for the week is 151.2.

▲ Interlake Iron Corp. and Wisconsin Steel division of International Harvester Co. increased prices of pig iron $2.00 to $65 a ton, citing higher costs for iron ore and coal as the factor necessitating increase.

▲ Appalachian Coals, Inc., announced a 25¢ a ton increase in the prices of all grades of soft coal produced in southern fields, effective April 1.

▲ The AISC reports that shipments of fabricated structural steel for January, 1957, amounted to 262,177 tons compared with 297,785 tons in December, 1956, and 251,498 tons in January, 1956; bookings in January, 1957, totaled 297,629 tons, December, 1956, 404,429 tons, and January, 1956, 405,396 tons. Backlog on January 31 amounted to 3,475,655 tons.

▲ Kaiser Steel Corp. reported that for the year 1956, sales were $201,489,824, income $23,571,852 or $6.57 per share, compared with 1955 sales of $155,354,222, income $7,610,843 or $1.67 per share.

March 6

▲ Commerce Dept. reported manufacturers business for January healthy with sales up to $28,700,000,000 an increase of $900,000,000 over December, 1956, and $2,300,000,000 higher than January, 1956.

March 7

▲ American Can Co. reports that production of metal cans in 1956 rose to 41,800,000,000, 6.7 per cent higher than 1955 production.

March 8

▲ The Commerce Dept. reported that personal income for January, 1957, was at an annual rate of $335,200,000,000, and $1,200,000,000 higher than December, 1956, and a gain of $18,500,000,000 over the yearly pace in January, 1956.

March 11

▲ The AISI reports that the operating rate of the steel industry for the week of March 11 is scheduled at 92.7 per cent of capacity. This is equivalent to 2,373,000 tons compared with 2,411,000 tons one week ago and 2,477,000 tons one year ago. Index of production for the week is 147.7.

▲ U. S. Steel Corp. increased prices of tin plate 4½ per cent effective April 30.

▲ Republic Steel Corp. and Fiat of Italy are planning construction of a $120,000,000 steelmaking plant at Vado Ligure near Genoa, Italy. Iron ore will come from Labrador.

March 12

▲ The Bureau of Mines reports that the consumption of scrap during January, 1957, totaled 6,626,000 gross tons and pig iron 6,482,000 gross tons compared with 6,264,955 tons of scrap and 6,396,468 tons of pig iron in December.

▲ The International Nickel Company of Canada, Ltd. annual report shows net sales for 1956 amounted

to $444,740,000, net earnings $96,296,000 equal to $6.50 per share, compared with sales for 1955 of $416,323,000, net income $91,566,000 or $6.14 per share. (All dollar figures in terms of U. S. currency.)

▲ Annual report of Eastern Stainless Steel Corp. shows sales for 1956 of $49,781,798, net earnings $2,250,944 or $3.75 per share; compared with 1955 sales of $37,774,029, earnings $2,530,933 or $4.21 per share.

▲ Superior Steel Corp. sales for the year 1956 totaled $29,005,605, net income $689,767 or $2.03 per share, compared with 1955 sales of $37,973,931, net income of $1,716,985 or $4.90 per share.

▲ The AISI reports that steel production in February, 1957, totaled 9,987,000 tons compared with output of 10,118,995 tons in February, 1956, production in the first two months of 1957 totaled 20,995,762 tons, 48,000 tons higher than the same period in 1956.

March 13

▲ Depts. of Commerce and Labor reported that employment in February rose 600,000 to 63,200,000, a new high for the month.

▲ According to the AISI report shipments of finished steel products during January, 1957, amounted to 7,809,451 net tons, compared with 7,064,093 tons in December, 1956, and 7,587,870 net tons during January, 1956.

▲ Interlake Iron Corp. announced 1956 sales and other revenues totaling $108,809,595, and net profit of $8,024,194 or $3.58 a share, compared with sales and revenues of $98,822,054 profit of $8,541,786, or $4.38 per share for 1955.

March 14

▲ United Engineering and Foundry Co.'s total net sales for the year 1956 amounted to $62,696,397, net earnings were $3,219,712, equivalent to $1.28 per share. For 1955 sales amounted to $47,723,198, earnings $2,192,608 or 87¢ per share.

▲ According to a January-February survey by the Commerce Dept. and the S.E.C., business outlays for new plant and equipment in 1957 head for a scheduled new high of $37,400,000,000, compared with $35,100,000,000 so spent in 1956.

March 15

▲ A bill to continue for another year the 52 per cent tax rate on corporate profits and existing excise levies on liquor, cigarettes and automobiles was quickly passed by The House with only a few dissenting votes.

March 16

▲ The Aluminum Assn. reports primary aluminum production in the United States during February, 1957, was 119,064 short tons compared with 147,030 short tons in January, 1957, and 132,762 short tons in February, 1956.

March 18

▲ The AISI reports that the operating rate of the steel industry for the week of March 18 is scheduled at 93.5 per cent of capacity. This is equivalent to 2,392,000 tons compared with 2,401,000 tons one week ago and 2,449,000 tons one year ago. Index of production for the week is 148.9.

▲ Jessop Steel Co. reports sales for 1956 amounting to $24,871,245 compared with $16,441,001 for 1955, 1956 earnings were $1,529,505 or $3.09 a share compared with $700,254 or $1.42 in 1955.

▲ The annual report from Pittsburgh Steel Co. lists sales for 1956 at $178,275,626, net income $6,225,000 or $3.24 per share; 1955 sales were $176,732,232, net income $7,515,470 or $4.09 per share.

March 19

▲ Electro Metallurgical Co. announced price decrease of 9/10¢ per lb for 50 per cent ferrosilicon and 1¢ per lb for silicomanganese, applying across the board to all grades, sizes, and quantities.

▲ The High Authority of the European Coal and Steel Community registered $25,000,000 of secured bonds, maturing in 1975, and $10,000,000 of serial secured notes, due 1960–62, with the S.E.C., first public offering in U. S.

March 20

▲ The Aluminum Assn. reported net shipments of aluminum sheet and plate totaled 114,686,000 lb during January, 1957; shipments of aluminum foil were 14,381,278 lbs.

▲ ARCI reports that deliveries of new domestic freight cars in February, 1957, totaled 7,655 compared with 7,822 in January, and 4,881 cars in February, 1956. Orders totaled 6,065 cars in February, 1957, compared with 5,328 in January, 1957, and 1,675 in February, 1956. Backlog of cars on order as of March 1, 1957, stood at 111,965 cars.

March 21

▲ Stockholders of Rotary Electric Steel Co. approved transfer of its stock and property to Jones & Laughlin Steel Corp. on the basis of 4 shares of J&L common stock for each 5 shares of Rotary Stock. It is contemplated that the transfer will be consummated April 30, subject to terms and conditions of the agreement which include approval by J&L stockholders on ratio of stock exchange.

March 22

▲ Secondary grades, No. 2 heavy melting, steel scrap sold in Pittsburgh for $38 a ton, down $7 from the previous transaction; offerings of No. 1 heavy melting scrap are available at $48 a ton, compared with $52 price established late in February.

March 25

▲ The AISI reports that the operating rate of the steel industry for the week of March 25 is scheduled at 92.0 per cent of capacity. This is equivalent to 2,354,000 tons compared with 2,392,000 tons one week ago and 2,452,000 tons one year ago. Index of production for the week is 146.5.

▲ The Industrial Heating Equipment Assn. reported that orders for industrial furnaces during February, 1957, amounted to $8,373,120 compared with $12,162,877 for February, 1956.

▲ Barium Steel Corp. announced that $4,965,000 or 99.3 per cent in principal amount of the 5½ per cent convertible debentures, due 1968, with right to convert terminating March 22, have been converted into common stock. Originally $5,000,000 principal amount was issued October 5, 1956, and this has been called for redemption on March 27, 1957.

▲ Copper prices pursue weakening trend with offerings reported in the custom smelter field at 30½¢ per lb, 1½¢ below quotations of major U.S. producers. Spot copper in London dipped to 29⅜¢.

March 26

▲ Industry sources predict shipments of machine tools in 1957 will hold close to the $886,000,000 shipped in 1956. However, bookings are expected to drop 15 to 25 per cent from the $924,000,000 booked in 1956.

March 29

▲ F. W. Dodge Corp. reported that construction contracts in the United States in February totaled $2,161,009,000, 3 per cent below February, 1956.

▲ AISC reported that shipments of fabricated structural steel in February, 1957, totaled 278,453 tons, compared with 262,177 tons in January, 1957, and 285,380 tons in February, 1956; bookings for February, 1957, amounted to 265,894 tons compared with 297,629 in January, 1957, and 331,497 tons in February, 1956.

MEMO
I wonder if a longer electrode would prove more economical?
MEMO
Let's call Great Lakes Carbon--they've always been helpful, and they're good people to work with!

ELECTRODE GLC® DIVISION

GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N.Y. · OFFICES IN PRINCIPAL CITIES

add Bearings, Inc. engineering service to a good idea . . . get a better product!

A prominent manufacturer of electrical motors uses 110 of these flyer assembly spindles to wrap insulating wire. They worked fine — much better than old type spindles but the life of the bearings averaged only one to two weeks per unit. This caused serious delays in production and an excessive bearing replacement cost.

Bearings, Inc. engineers were given the problem. All spindles were shipped to our complete Spindle Repair Department in Cleveland. The housings and shafts were reworked to accommodate a machine tool precision bearing with proper clearances and preloads to meet the most rigorous service demands.

Within a short time these spindles were back in service, operating at higher speeds than had been possible before. They wind evenly with uniform tension, wire breakage is eliminated and the bearings are giving exceptional service life.

Do you have a bearing problem? Want replacement bearings in a hurry? Ask our branch nearest you for *any* service involving bearings — they're ready NOW to help you!

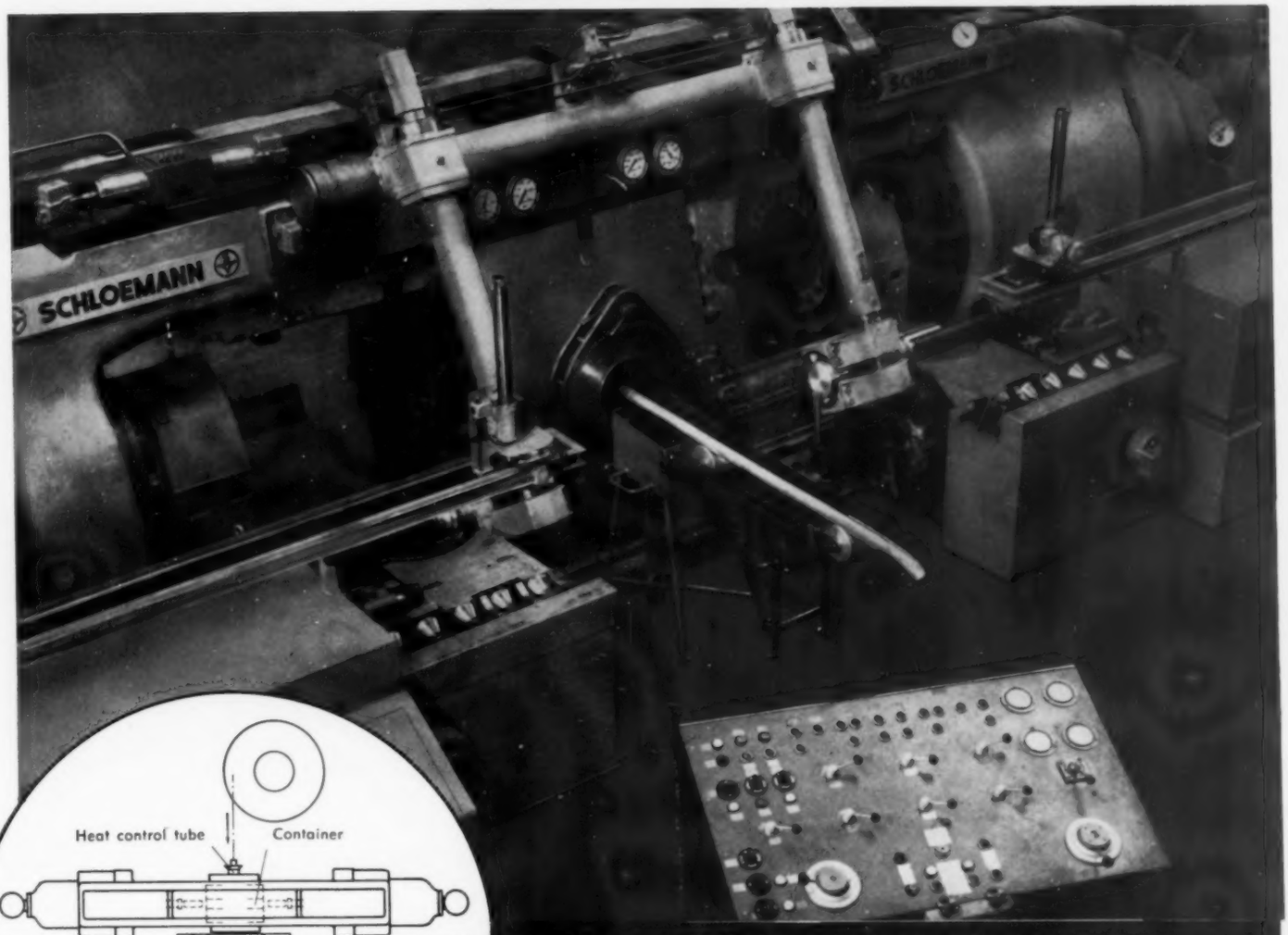
Rendering bearing service in the territories adjacent to our branches, listed below.

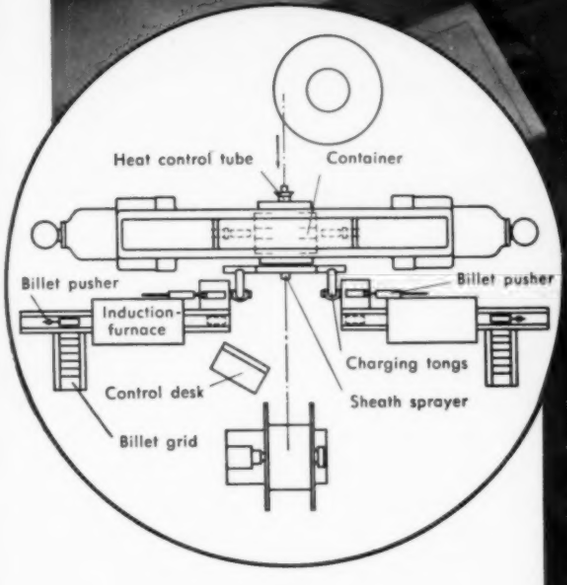
BEARINGS, INC.

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Mansfield • Toledo • Youngstown • Zanesville
INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute
PENNSYLVANIA: Erie • Johnstown • Philadelphia • Pittsburgh • York
WEST VIRGINIA: Charleston • Huntington • Wheeling
NEW JERSEY: Camden • **MARYLAND:** Baltimore
DELAWARE: Wilmington •
Subsidiaries Balanrol Corp. • Buffalo, N.Y.•
Kentucky Ball and Roller Bearing Co. • Louisville, Ky

SCHLOEMANN

Aluminum Cable Sheathing Press





This 1760 ton unit, FIRST of several to be erected in the United States, is now being installed at a plant of GENERAL CABLE CORPORATION.

Unique advantages may be attained with this small unit

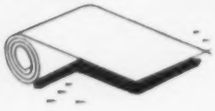
Cable of any desired length can be sheathed, up to 2 3/8 in. or 4 in. o. d. respectively · High efficiency, as two solid billets are extruded against each other with low power requirements · Direct self-contained oil-hydraulic pump drive for the extrusion, combined with accumulator for shortening the dead periods · Simple and quick automatic operational sequence · Smooth, perfectly welded cable sheaths with a uniform grain structure · Effective heat protection of the cable core insulation · Economical production even of very thin-walled tubes, and of sections and wire

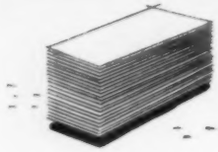
FELLER ENGINEERING COMPANY 1159 Empire Building, Pittsburgh 22, Pa.

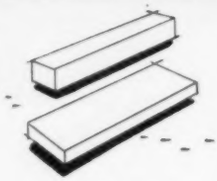
HOT AND COLD ROLLING MILLS • COUNTERBLOW HAMMERS • HYDRAULIC PRESSES

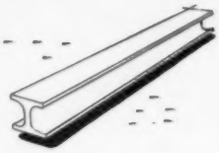
WHEELABRATOR®
mechanical descaling

SAVES LABOR, SPACE, MONEY AND METAL WHEREVER IT'S USED ON STEEL!


STRIP

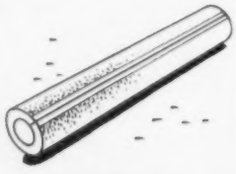

SHEET

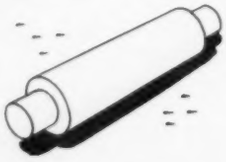

SLABS & BILLETS


STRUCTURALS

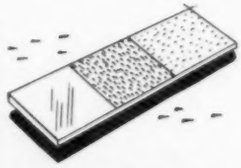
BAR STOCK

WIRE ROD


PIPE SKELP


MILL ROLL ETCH

MOLD CONDITIONING


SPECIAL FINISHES

HOW WHEELABRATOR SAVES

- Replaces or reduces acid pickling
- Saves acid, acid disposal
- Removes only scale – no metal
- Reduces manhour needs
- Requires only 1/3 to 1/2 the floor space
- Gives improved surface for cold working and cold forming
- Reduces need for scale breaking

Wheelabrator mechanical descaling has proved it can remove scale from steel, using little or no acid, and do it faster at less cost than is possible with acid pickling. Over 90 installations have demonstrated this process is cheaper, more efficient and provides a clean material that produces an improved end product. Wheelabrator descaling itself uses no acids or pickle liquors. It removes scale with an abrasive blast from one or more rotating wheels. Each wheel hurls abrasive in a fan-shaped blast pattern against the surface of the material being cleaned. It covers the entire surface (or any portion of it desired) in such a way that it is uniformly blasted to remove scale at a constant rate. This rate can be controlled to suit the requirements of the job.

In many cases, no further cleaning is required and acid pickling is completely eliminated—particularly where the end product does not require cold reduction. This means complete elimination of acid costs, acid disposal problems, virgin metal loss and other inherent disadvantages of acid pickling. Mechanical descaling is adaptable to virtually any speed of production and requires only 1/3 to 1/2 the space needed for acid pickling. The flexibility of mechanical descaling permits its easy integration into lines already in existence and facilitates design and planning of new installations.

For more information on Wheelabrator for principles and savings, write today for your free copy of Catalog 74-C.

WHEELABRATOR
CORPORATION
396 South Byrkit Street Mishawaka, Indiana

Nation's Pipe Mills Expand Capacity

SUTTON STRAIGHTENERS USED FOR FINISHING

Nine new Model 2JM Sutton straightening machines as shown at right either are now in use or are being built to order for leading pipe mills.

Three Model 2JM Special straighteners are installed at Jones and Laughlin Steel Corporation's Aliquippa Works. Two of these are for operation directly in a mill line for ½" to 1½" pipe while the third is to be used for job lot straightening. In addition, two Model 2JM Modified straighteners have been delivered to J & L for 1¼" to 4" pipe.

A Sutton 2JM Modified straightener is in operation at the National Tube Division of United States Steel Corporation's Fairless Works for ½" to 4" pipe. Other recent purchases of 2JM straighteners have been made by Laclede Steel Co. for ½" to 4" pipe and Wheeling Steel Corporation for ½" to 4" pipe.

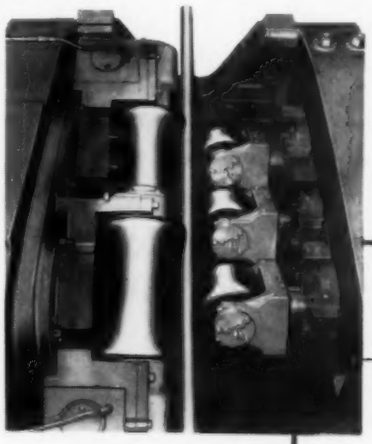
A complete line of Sutton straighteners are built for many different applications. The new Model 2JM is especially recommended for straightening continuous weld and butt weld pipe. It is meeting with wide favor because of extreme dependability of operation at high production speeds up to 1000 feet per minute and faster. Roll diameters, bearings, roll drives and other components of the machine all are engineered for continuous high speed operation.

Incorporating the Sutton 5-roll principle, rolls are positioned in a horizontal pass line. While guides ordinarily are used for safety these straighteners operate with or without guides at the option of the user. All adjustments are readily accessible and easy to perform, there is good visibility of the working area and the machines are easy to set up and change-over quickly with roll setting fast and sure. In addition to its many other advantages the horizontal pass line permits scale and coolant to fall away into a disposal pit for faster, cleaner operation.

STRAIGHTEN *PIPE*

AT 1000 FPM and FASTER!

Specifically designed to meet the demands of today's continuous-weld pipe mills for steady, dependable production at highest straightening speeds.



- DEPENDABLE SERVICE
- HIGH PRODUCTION
- QUALITY STRAIGHTENING
- EASY SCALE DISPOSAL

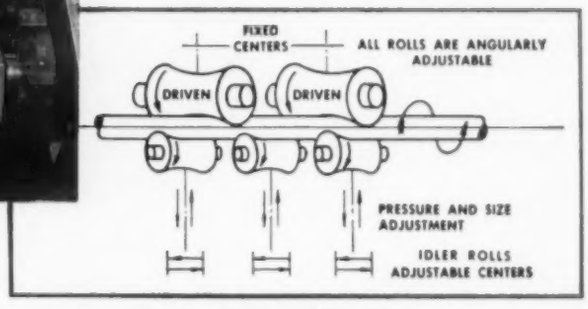


Photo and diagram of 5-roll design shows engineering principle of driven rolls with opposed idler rolls.

Ask for Bulletin No. 25

SUTTON *Engineering* COMPANY

Manufacturers for Ferrous and Non-Ferrous Metal Industries

STRAIGHTENERS, EXTRUSION PRESSES, HYDRAULIC STRETCHERS, SHEET LEVELERS, CONTOUR CORRECTING MACHINES, STRAIGHTENING PRESSES, ROTARY CLEANERS, HEAVY-DUTY UNIVERSAL JOINTS, ROLLS

FIRST NATIONAL BANK BLDG., PITTSBURGH 22, PENNSYLVANIA

PHONE: GRANT 1-8077 **PLANT: BELLEFONTE, PA.**

2,300,000 pounds ship-to-shore in one hour!

Westinghouse-equipped ore unloaders set new highs in speed and dependability for McLouth Steel

Power. Durability. Precision. These were the requirements for the motors and controls to operate these two 547-foot ore bridges for McLouth Steel. Westinghouse supplied the solution with rugged MC mill motors and the newest developments in automatic controls—Magamp* and Rototrol®.

In just 41 seconds, these ore bridges run a complete cycle—digging, hoisting, trolleying, dumping, rehoisting and back again for another 27,000-pound scoop.

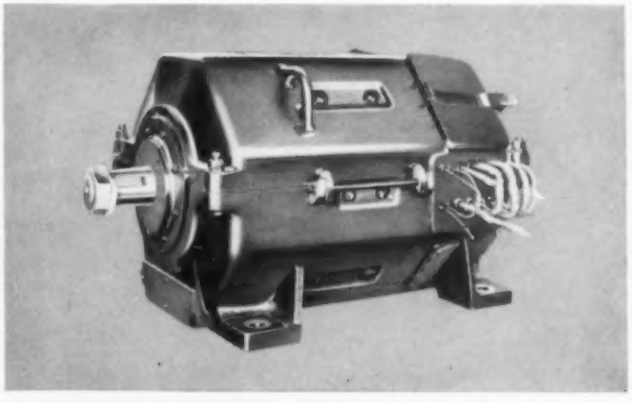
It will pay you to investigate the facts that give such outstanding results as these when you are considering motors, drives and controls. Get the details from your Westinghouse sales engineer. Or write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.

*Trade-Mark
J-21957

YOU CAN BE SURE...IF IT'S

Westinghouse

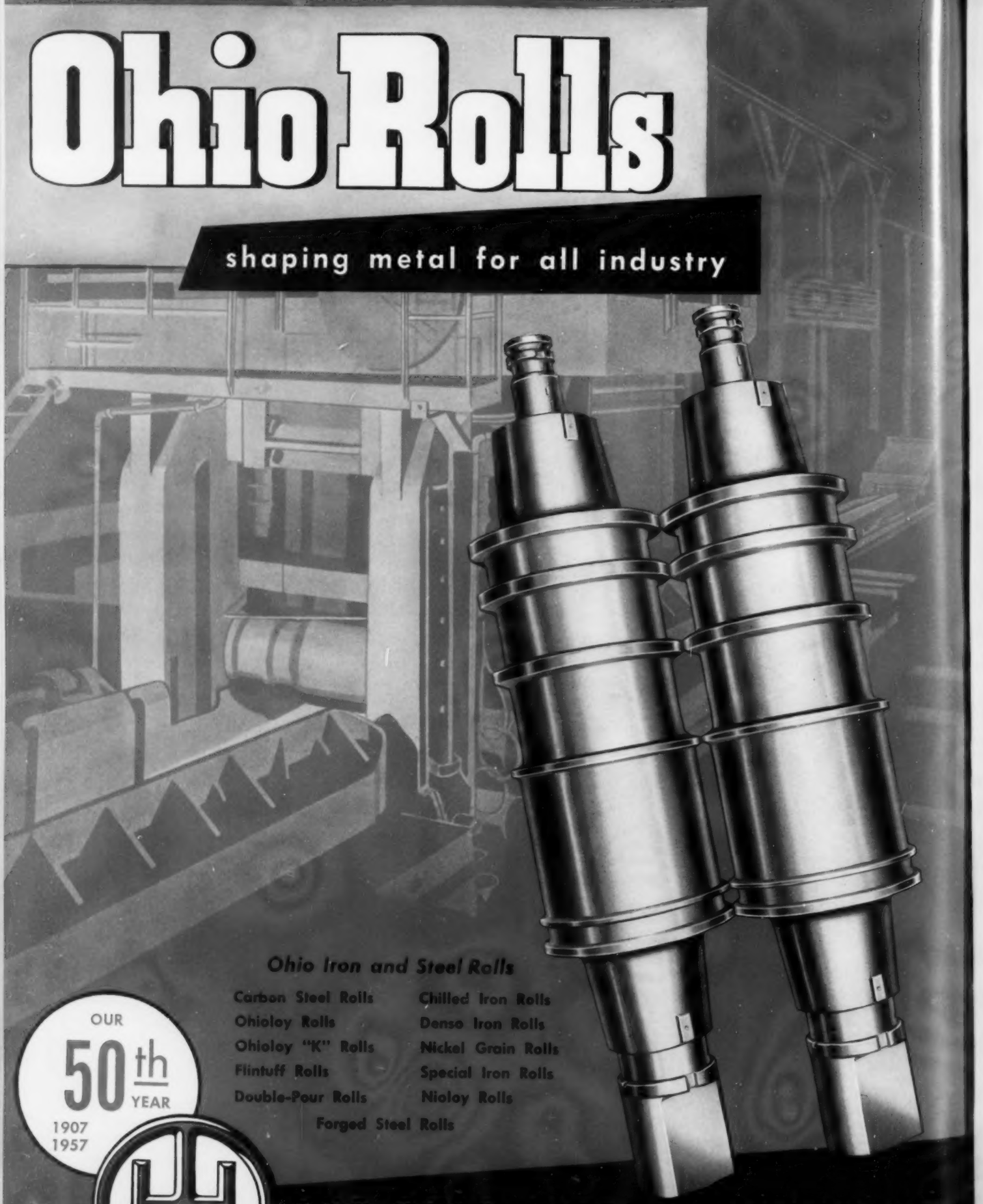
These two new ore bridges can unload all size boats by means of an adjustable "apron" which can be raised high enough to allow the mast of any vessel to pass underneath. Dependable Westinghouse hold-and-close motors carry the load on this modern installation.



Rated at 187½ hp, 230 v, 460 rpm, this 616 Series mill motor gives the kind of outstanding performance to meet today's tougher, faster jobs. Westinghouse engineers are ready to work with you to give you the best motors and controls for your needs.

Ohio Rolls

shaping metal for all industry



Ohio Iron and Steel Rolls

Carbon Steel Rolls
Ohioloy Rolls
Ohioloy "K" Rolls
Flintuff Rolls
Double-Pour Rolls
Chilled Iron Rolls
Denso Iron Rolls
Nickel Grain Rolls
Special Iron Rolls
Nioloy Rolls
Forged Steel Rolls

OUR 50th YEAR
1907
1957

THE OHIO STEEL FOUNDRY CO.
LIMA, OHIO

Plants at Lima and Springfield, Ohio

Industry News...

THREE NEW BUILDINGS SCHEDULED FOR ALLEGHENY LUDLUM'S BRACKENRIDGE RESEARCH LABORATORY

▲ Allegheny Ludlum Steel Corp. announced that construction will start shortly on the first of three new buildings which will be built this year at the company's research and development laboratory in Brackenridge, Pa. Two buildings are already on the site, and the addition of two laboratory buildings and an administrative building this year will make it possible for the company to centralize all its research facilities at this location.

Grading in preparation for the construction is already under way on the site. The first building will be a heavy laboratory structure to be constructed of stainless steel, masonry and glass. It will house heavy research and development processing equipment, including a 500-ton forging press, a hot sheet and bar rolling mill for development work, a pilot size cold rolling mill, furnaces, a slitting and edge trimming unit, and an annealing, pickling, and coating line for experimental processing.

The company hopes that construction of this unit will be completed this year, and expects to ask for bids for construction of a light laboratory building and the administrative building within the next few months.

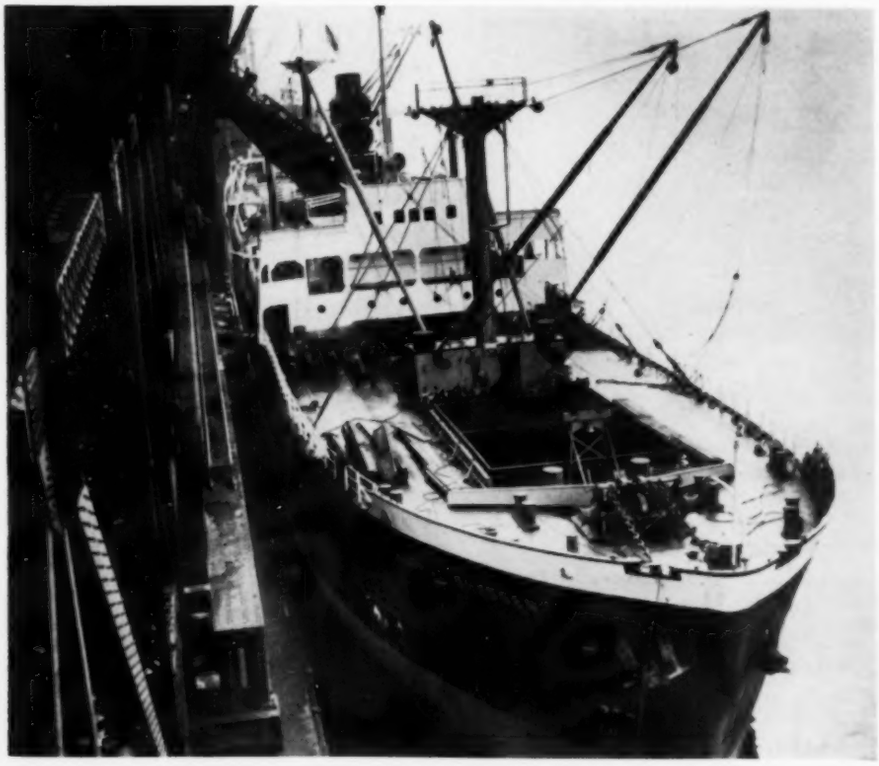
ENTER JOINT VENTURE FOR ORE EXPLORATION

▲ Granite City Steel Co., and the American Zinc, Lead and Smelting Co. have entered into a joint venture agreement for the purpose of exploring ore fields within the state of Missouri.

The agreement contemplates the development of mining properties for the use of both companies in the event that any commercial ore discoveries are made. The expenses of exploration and development will be shared equally by the two companies. The operation of any properties that may be developed, however, will be handled by American Zinc.

GERMAN STEELMAKER LOADS UP WITH U. S. COAL

U. S. coal to aid European industry and alleviate the fuel shortage is loaded through giant chutes at Newport News, Va., into the S. S. August Thyssen, a victory ship recently purchased by August Thyssen-Huette A.G., leading German steelmaker. The freighter runs regularly between Newport News and Rotterdam, where the coal is sent up the Rhine on barges to the Thyssen-Huette's own port and mills at Hamborn, in the Ruhr industrial valley.



RELINE NO. 2 FURNACE AT ALIQUIPPA WORKS

▲ The No. 2 blast furnace at J&L's Aliquippa Works was "blown out" March 3 for a complete relining job.

Originally "blown in" over 20 years ago the original "hearth and bosh" section never has been replaced. During this period, No. 2 furnace produced over 5,184,000 tons of iron.

No. 2 is about 90 ft high, and has a hearth diameter of 21 ft six in., but will be enlarged during the relining to a diameter of 28 ft six in. This will make her equal in size to the two largest of the five blast furnaces at the Aliquippa Works.

After enlargement, the furnace will be able to produce 1270 tons of iron a day, an increase of 370 tons over present capacity.

The entire relining project is expected to be completed within 90 days.

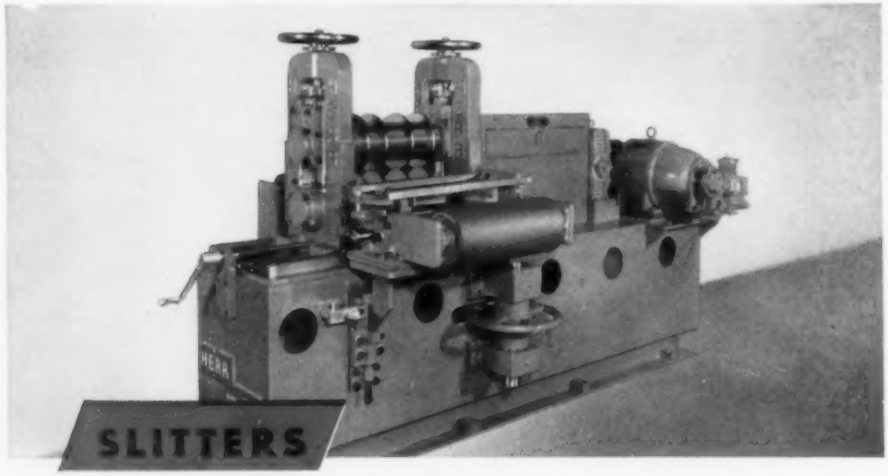
ALLIED AND KENNECOTT FORM TITANIUM COMPANY

▲ The association of Allied Chemical & Dye Corp. and Kennecott Copper Corp., formed to produce and sell titanium metal, will be known as Allied-Kennecott Titanium Corp.

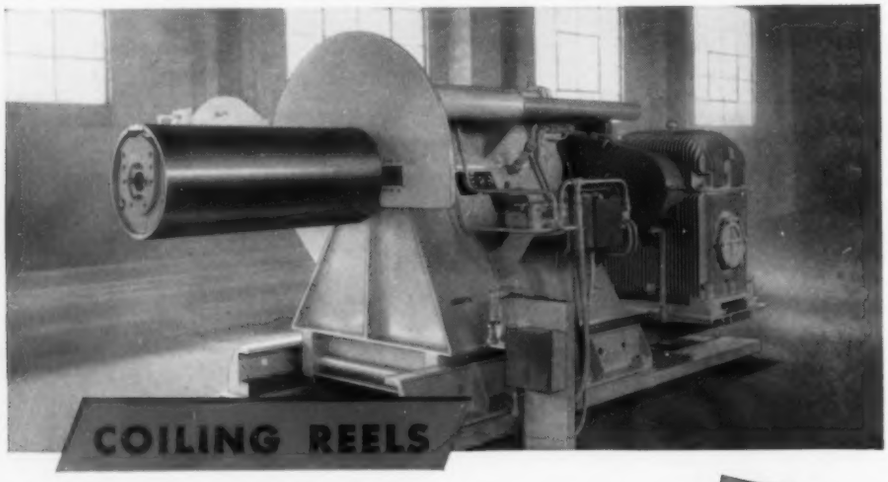
The new company will produce titanium chloride, titanium sponge, and titanium billets and, according to the production schedule set by Allied and Kennecott, operations are expected to begin late in 1958.

HERR EQUIPMENT

"Complete Processing and Handling Equipment . . . for any Ferrous or Non-Ferrous Material . . . That Starts — or Ends — as a Coil"



Built to insure dependable, high precision slitting. All thicknesses from .001 to ⅛", any commercial width. Quick, extremely accurate knife set-up. Also complete high precision slitting lines including pay-off reel, leveler, slitter, scrap winder, scrap chopper and coiling reel.



Wide variety of types and sizes for coiling ferrous and non-ferrous strip. Fixed, adjustable or automatically aligning bases. Automatic oscillating level winding drive if desired. Link type contracting mandrels; manually or hydraulically operated. Furnished complete ready for use.

Write for fully descriptive Bulletin No. 561 today!

THE HERR EQUIPMENT CORPORATION

1270 VINE STREET • WARREN, OHIO

CLEVELAND, INDIANAPOLIS AND BERKELEY, CALIFORNIA

Until a titanium producing plant is put into operation, the company's interim office will be located in Solvay, N. Y., with Raymond Largent, vice president and project manager in charge. Mr. Largent, an Allied employee for 20 years, has been chief engineer of Allied's Solvay Process Division since August, 1953.

The new corporation makes it possible to utilize the complementary technological resources and experience of the Allied and Kennecott organizations in chemical processing and metal fabricating. Allied's continuous process for making titanium sponge will be used as well as their method for manufacturing titanium tetrachloride by using titanium slag as the raw material. Techniques for melting and fabricating titanium into sheet, rod, and tubing, developed by Chase Brass & Copper Co., a Kennecott subsidiary will be utilized.

TO BUILD OPEN HEARTH FOR CHILEAN COMPANY

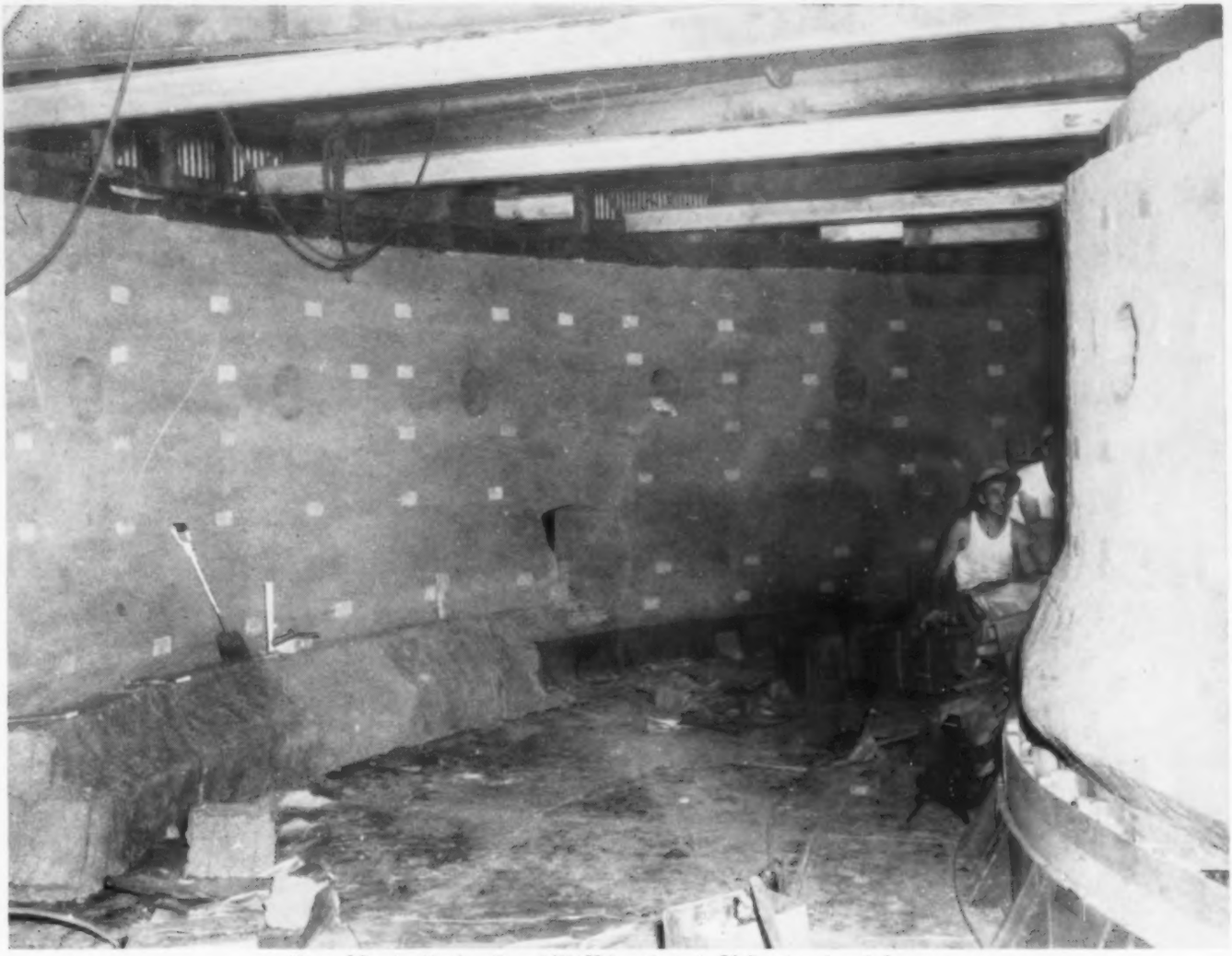
▲ A contract to design, purchase certain equipment, and supervise erection of an open hearth furnace for a Chilean steel firm was announced by Koppers Co., Inc., Engineering and Construction Division.

The open hearth furnace, having a capacity of 200 metric tons, will be constructed for Compania de Acero del Pacifico of Santiago, Chile. When completed the furnace will be the fourth at the Chilean firm's Huachipato works. At the present time there are three 100 metric ton furnaces in operation.

The new furnace is part of an overall $26,000,000 improvement and expansion program which will extend over the next two years. The Export-Import Bank has recently granted a $16,000,000 credit to the Chilean firm to help finance purchases of equipment and technical services in the United States.

Koppers has acted as management adviser and consultant since the founding of the Chilean company and has a substantial stock interest therein. The present program was developed as a result of a survey made by a special Koppers consulting team in conjunction with the local plant people.

Koppers will continue to furnish consulting services on all phases of the improvement and expansion.



View of Ramtite lined walls and WASP hearth rim in 56 ft. rotary hearth furnace.

Proven Performance Paves The Way To NEW FURNACE Orders For Ramtite®

Cost reducing performance in existing furnaces of an eastern steel mill led to the installation of Ramtite products in the outer and inner walls, sub-hearth and hearth rim of this 55 ft. rotary hearth furnace. The furnace was designed and built by Salem-Brosius, Inc.

Ramtite Safe-Tie Refractory Anchors securely tie the walls back to the steel structure to prevent bulging. Combined with Ramtite's inherent spall resistance, this assures longer wall life.

The hearth rim is lined with WASP, a special grade of air setting Ramtite which develops very high strength at moderate temperatures, eliminating the difficulties often experienced with rim tiles which spall or work loose, move out and jam into the sides of the furnace.

The Ramite Co. offers you a complete sales engineering service—experienced men who are always available to study your refractory problems and consult with your engineering, mason and ceramic departments about your specific needs.

Write for free bulletin or call your local Ramtite representative for further information.

Ramtite Is Our Business Not a Side Line

The Ramtite Co.
DIV. OF THE S. OBERMAYER CO.

THE RAMTITE CO., Div. of The S. Obermayer Co.
1813 South Rockwell St., Chicago 8, Ill.

Please send items checked

- ☐ Bulletin on Ramtite Plastic Refractory in Steel Plant Furnaces.
- ☐ Bulletin on Castable and Gunning Refractories.

Company Name_____

Attn. Mr._____ Title_____

Address_____

City_____ Zone_____ State_____

© 1957 This is another in a series of advertisements depicting ways Ramtite Refractories serve the steel industry.

Syntron V-500 Vibrator on an 8'x24' ore chute

SYNTRON Electromagnetic
BIN VIBRATORS

—keep bulk materials flowing freely through bins, hoppers, and chutes.

When attached to bins, hoppers and chutes, Syntron Bin Vibrators provide an efficient and economical means of keeping bulk material flowing freely through discharge openings to feeders, conveyor belts, furnaces, trucks, etc. They utilize their powerful 3600 vibrations per minute which is instantly controllable from minimum to maximum, to keep coal, ores, limestone, sand, ashes and other materials from sticking and plugging bins and chutes—Eliminates lag in production supply lines. Do away with the dangerous and inefficient manual rodding and poking methods of freeing bulk materials.

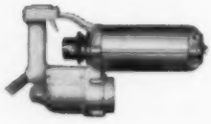
Syntron Bin Vibrators are sturdily built for 24 hour-a-day operation with a minimum of maintenance. Available in a range of sizes to handle from 1 cubic foot hopper to big bins and bunkers.

Our Applications engineers will gladly submit recommendations per your request.

Other SYNTRON Equipment of proven Dependable Quality

BATTERY CHARGES

ELECTRIC HAMMERS



LAPPING-POLISHING MACHINES

Write for complete Syntron Equipment catalog — FREE

SYNTRON COMPANY
699 Lexington Avenue Homer City, Penna.

CLARK CONTROLLER CO. BUYS CLEVELAND PLANT

▲ The Clark Controller Co. has completed arrangements to purchase a 170,000 sq ft building at 10101 Woodland Ave., Cleveland, from Western Electric Co. and The Ohio Bell Telephone Co. The new building will be utilized for expansion of manufacturing and warehousing capacity.

Clark will occupy the building in late 1957, after the operations now being conducted there by Western Electric and Ohio Bell have been transferred to Western Electric's new plant at Solon, Ohio.

H. K. PORTER COMBINES REFRACTORY DIVISIONS

▲ Two divisions of H. K. Porter Co., Inc.–Laclede-Christy, and McLain Fire Brick have been combined under common management. To be known as the Refractories Division, it also will bring under the one management the newly acquired Mullite Refractories, Shelton, Conn. The Refractories Division will be headed by S. R. Gurley, Jr., as its vice president and general manager. W. Alfred Turner, former vice president and general manager of McLain Fire Brick, is now a vice president of H. K. Porter Co., Inc., and in that capacity will act as adviser and consultant on refractory matters, reporting directly to Porter's president, C. L. Holbert.

The Refractories Division now is able to serve all users of refractories having applications ranging in service temperatures up to 3400 F. Multiple product lines make it possible for Porter to meet "super" specifications for unusual applications.

FIRST LARGE TINPLATE COILS SHIPPED BY J&L

▲ The first king-sized coils of tinplate for use in can manufacturing have been shipped by Jones & Laughlin Steel Corp. from its Aliquippa Works. The shipment marks not only a "first" for J&L but for the steel industry as well. It represents a significant trend in the method of handling tinplate, a method which has prevailed for years.

The 15,000-lb coils of tinplate

single stand reversing plate mill

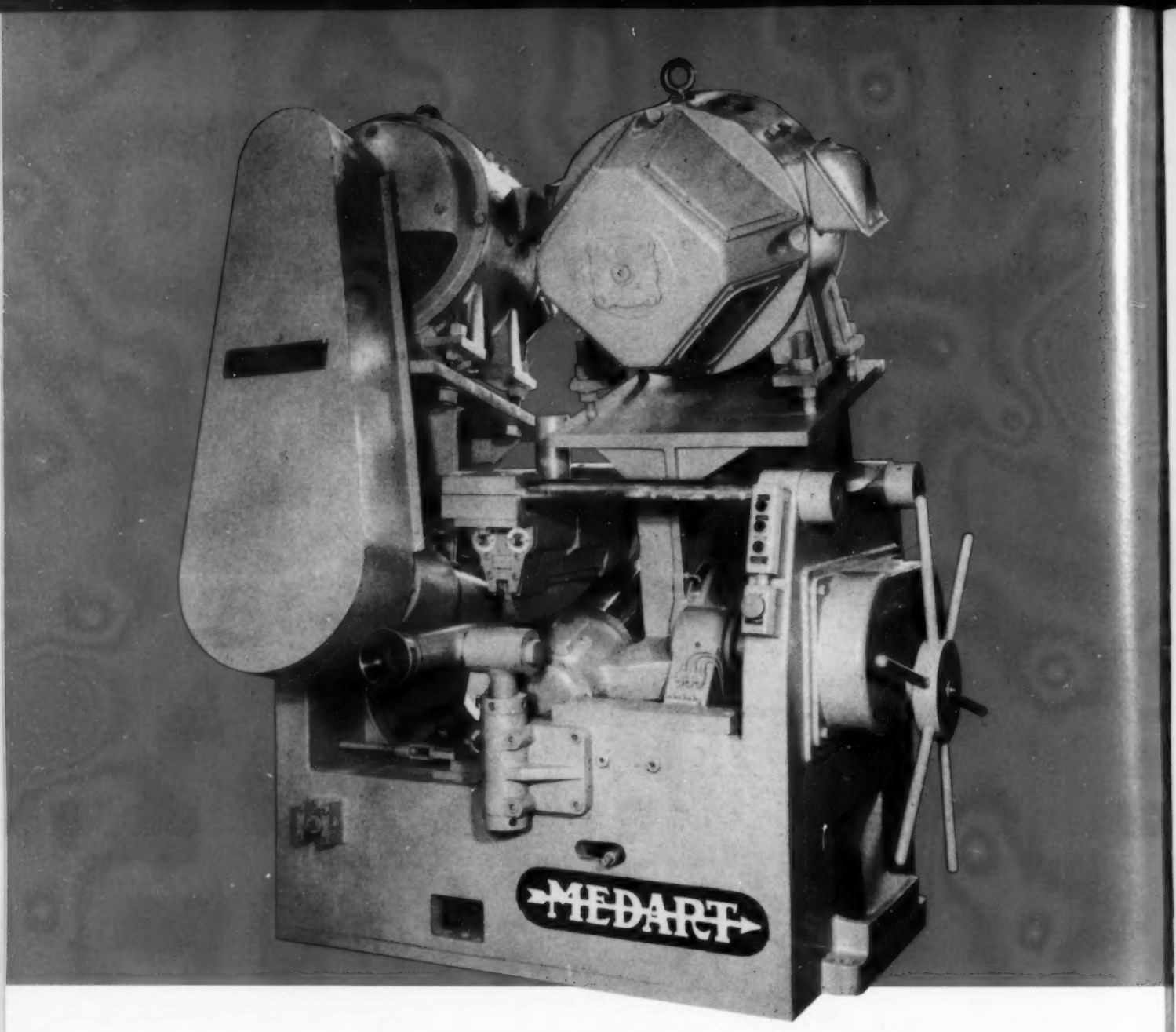
BLAW-KNOX PLATE MILLS

Blaw-Knox designs and builds a full range of continuous or single stand reversing plate mills for rolling ferrous and non-ferrous slabs. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations including all auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron, and steel rolls, Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

BLAW-KNOX

BLAW-KNOX COMPANY

Foundry and Mill Machinery Division
Blaw-Knox Building · 300 Sixth Avenue
Pittsburgh 22, Pennsylvania



BLAW-KNOX MEDART makes what it takes

for high speed straightening of cold finished stock

Designed around the principle used in the famous Blaw-Knox Medart 2 roll Rotary Straightener, the 2 & 2 Universal Straightener is especially adapted for high speed applications. It is widely used in a direct production line with a draw bench for high speed straightening of cold drawn bars.

In this machine, each roll is driven by its own motor through a completely enclosed V-Belt drive. This simplified arrangement keeps downtime and drive maintenance to a minimum. What's more it provides for control of throughput rates by varying the speed of the motors. Roll speeds are synchronized by means of electrical interlocks between the motors.

Space requirements are kept to a minimum through compact design and the small number of working parts. This compact setup simplifies discharge of work from the machine, making it ideally suited to shorter length workpieces.

The Blaw-Knox Medart 2 & 2 Universal Rotary Straightener and Polisher is available in sizes to handle bars and tubes in diameters of ⅛" to 4½". Contact us for detailed information, technical assistance or service.

BLAW-KNOX

BLAW-KNOX COMPANY

Foundry & Mill Machinery Division

Blaw-Knox Building • 300 Sixth Avenue

Pittsburgh 22, Pennsylvania

CONTINENTAL

were shipped by rail to the American Can Co. plant in Tampa, Fla.

The traditional way of shipping tinplate from the mills to can makers has been in packages of cut sheets. Some coils have been shipped in the past, but they were of a maximum size of 7,500 lb.

The coils are being shipped in a position different from that usually used for coils. The large coils are placed on pallets with the core or "eye" vertical, as compared with the previous method of shipping the smaller coils in an upright position on platforms with the "eye" horizontal.

The eye-vertical position enables two or three coils to be placed on top of each other in storage, which results in a saving of storage space.

DRAVO TO MANUFACTURE SCHENCK-DESIGNED UNITS

▲ Entry into a new field of materials handling has been announced by Dravo Corp. The company has been licensed by Carl Schenck Co., of Darmstadt, Germany, to manufacture Schenck-designed vibrating feeders, screens and conveyors in this country.

Although Schenck screens and conveyors have been used successfully in this country and Europe for many years, many Schenck-designed products were not previously available in the United States. Key feature of the Schenck equipment is an exciter element which imparts a "micro-thrust" movement to materials being moved or screened. The resultant frequency oscillation results in low wear, resistance to high temperatures, low head room requirements for installation and transmission of minimum vibration to surrounding structures.

Unlike the more common belt conveyor, the Schenck conveyors do not carry material from one point to another. Through vibration, these machines literally throw particles forward in a series of parabolic arcs so small that the material appears to flow to its destination.

Combinations of Schenck screens, feeders and conveyors are used to great effect in iron ore sintering plants, particularly for moving hot abrasive sinter material, which leaves the sintering plant at temperatures up to 1450 F far too hot to be transported on a rubber belt.

AT LARGE MIDWESTERN MANUFACTURING PLANT*

Diamond INDUSTRIAL TV

Fire-Watches 29 Acres of Roof

Saves $20,000 PER YEAR

Viewing Screens in basement guardroom enable guard to watch the roof easily and comfortably in addition to other duties.

Two tower-mounted Diamond ITV Cameras automatically sweep back and forth watching the 29 acres of roof. This installation has been in continuous operation since September, 1955.

Remotely controlled zoom lenses . . . remote control to stop, start or angle either camera, enables the guard to take a close look at anything suspicious. Remotely controlled windshield wipers on weatherproof camera housings keep viewing windows clear in bad weather. Fire hasn't a chance to get a serious start.

Savings in guard wages amount to $20,000 per year . . . will more than pay for the installation in a year. Lonely and sometimes unpleasant jobs are eliminated. Have you explored the money saving resources of Diamond ITV? Call your Graybar Distributor, or use the coupon below.

*Name on request.

7729

DIAMOND POWER SPECIALTY CORP.
"FIRST IN INDUSTRIAL TELEVISION"
ELECTRONICS DEPT., P.O. BOX 57N
LANCASTER, OHIO

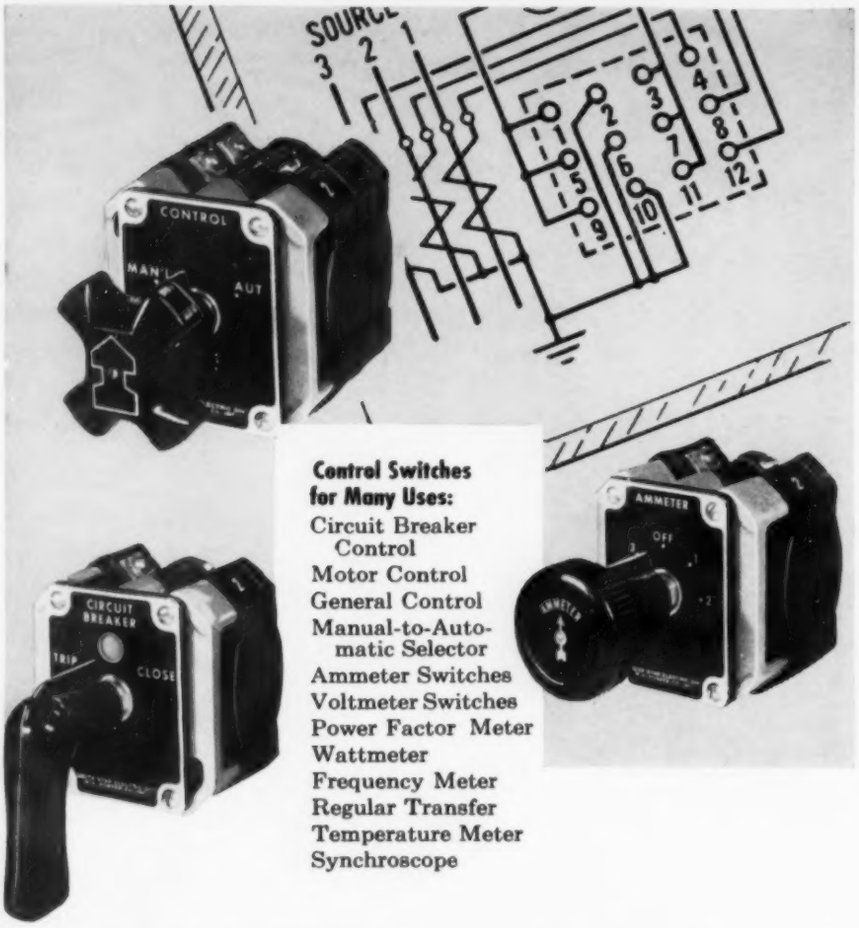
Please send me without obligation a copy of new bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs, improve quality, increase sales and aid safety.

Name_____

Title_____

Company_____

Address_____



Control Switches for Many Uses:
Circuit Breaker Control
Motor Control
General Control
Manual-to-Automatic Selector
Ammeter Switches
Voltmeter Switches
Power Factor Meter
Wattmeter
Frequency Meter
Regular Transfer
Temperature Meter
Synchroscope

Need rugged Control Switches? See Delta-Star's new line

These new Type M-2 Delta-Star control switches designed for D.C. or A.C. service give you important new features that mean improved operating efficiency and economy.

1. **Versatility**—designed for many uses from motor controls to synchroscopes. Switches are rated 20 amps. continuous rating with 250 amp. three-second rating.
2. **Compactness**—only 3⅞ in. high by 3¼ in. wide; new design permits easy wiring, quick inspection.
3. **Rugged and long-lasting** — heavy duty parts; high Delta-Star quality construction.
4. **High interrupting capacity**—single break contacts rated 25 amps. at 250 volts a.c., double break rated 75 amps.

Delta-Star now offers premium control switches at regular prices. Ask your Delta-Star representative about them or write *Delta-Star Electric Division, H. K. Porter Company, Inc., Chicago 12, Illinois. District offices in principal cities.*

HKP DELTA-STAR ELECTRIC DIVISION
H. K. PORTER COMPANY, INC.

In the initial stages of its operation, Dravo will manufacture frames for all of these various types of equipment but will import from Schenck the heart of the unit—the exciter—and will maintain a stock of these units in this country. The exciter itself consists of rotating unbalanced weights driven by an electric motor at speeds up to 1500 rpm. This action creates the "micro-thrust" vibration which moves the material.

TO INSTALL SHEARS AND INSPECTION BEDS

▲ A contract to design, build and install cold structural shears, inspection beds and a roller table system for United States Steel Corp.'s new structural mill now under construction at South Works, Chicago, Ill., has been awarded to the Loewy-Hydropress Division of Baldwin-Lima-Hamilton Corp.

The shears, each with a 700-ton capacity, will have a complete automatic cutting cycle. Permanent tool changing devices are provided for shortest tool changing time. Directly in back of each shear will be a friction saw for cold material, such as "Z"-Bars and sheet pilings.

The inspection beds will be designed to turn material 180 deg. If required, these beds can operate as transfer beds by withdrawing the turning device. The run-in and run-out tables leading to and from the inspection beds and shears will be equipped with individually driven rollers.

Operation of this plant is expected to start in 1958. The wide variety of shapes that will be produced there will add greatly to U. S. Steel's structural product output.

AWARDS COKE OVEN CONTRACT TO KOPPERS

▲ United States Pipe and Foundry Co. has awarded Koppers Co., Inc., a contract to design and erect a battery of 60 coke ovens at its Birmingham, Ala., operations.

The new battery will be the Koppers type gun flue ovens with certain auxiliary equipment. When completed the U. S. Pipe and Foundry coke oven capacity at Birmingham will be increased approximately 30 per cent. The new ovens will have the capacity to carbonize 1160 net tons of coal per day. At

the present time U. S. Pipe has 180 ovens in use at Birmingham. Two batteries, consisting of 30 ovens each, were previously built by Koppers.

ACQUIRES RIGHTS TO PELLETIZING PROCESS

▲ The exclusive rights to license the process and equipment for pelletizing iron ore by the Erie Mining Co. shaft furnace method, which is covered by a large number of patents in this country, Canada and many European and South American countries, have been acquired by Surface Combustion Corp.

A. L. Hollinger, vice president and general sales manager, announces that Surface is prepared to design and build complete pelletizing plants.

Surface is presently constructing 24 furnace units for the Erie commercial taconite plant at Hoyt Lakes, Minn. This new, 300 million dollar project will be the largest installation of its kind, having a designed capacity for initial production of 7½ million gross tons per year. Surface is also building 3 units for the pelletizing plant at the Hilton Mines near Ottawa, Quebec.

INLAND ORDERS SLABBING MILL CONTROL SYSTEM

▲ The Inland Steel Co. has placed an order with the General Electric Co. for a static switching control system, to be used for a slabbing mill in the company's plant at East Chicago, Ind.

It will be the second installation of a static switching system in the steel industry. The first such installation was made last year on a four-stand tandem cold mill at the Indiana Harbor, Ind., plant of Youngstown Sheet and Tube Co.

TO SUPPLY LUBRICATION SYSTEM FOR KAISER MILL

▲ Dravo Corp. will supply three custom - designed Dravo - DeLaval mill lubrication systems to Blaw-Knox Co. for installation on a 46-in. by 90-in. Universal slabbing mill. The mill is being built for the Kaiser Steel Co. plant at Fontana, Calif.

One system will provide a 125 gpm flow of 2200 SSU oil at 100 F to

FAST, COST-REDUCING INSTALLATION with longer, lighter track sections.
INCREASED SAFETY with enclosed bus bars, unique trolley arm Safety-Slot.

DEPENDABILITY ASSURED—strong aluminized steel housing, rugged petticoat insulator, husky trolley components.

New LEC-TROL-FEED System

for fast-action installation . . . safety-first power

This new, preassembled LEC-TROL-FEED conductor system gives you outstanding advantages for supplying electric power to cranes, hoists, welding units and other straight-runway equipment.

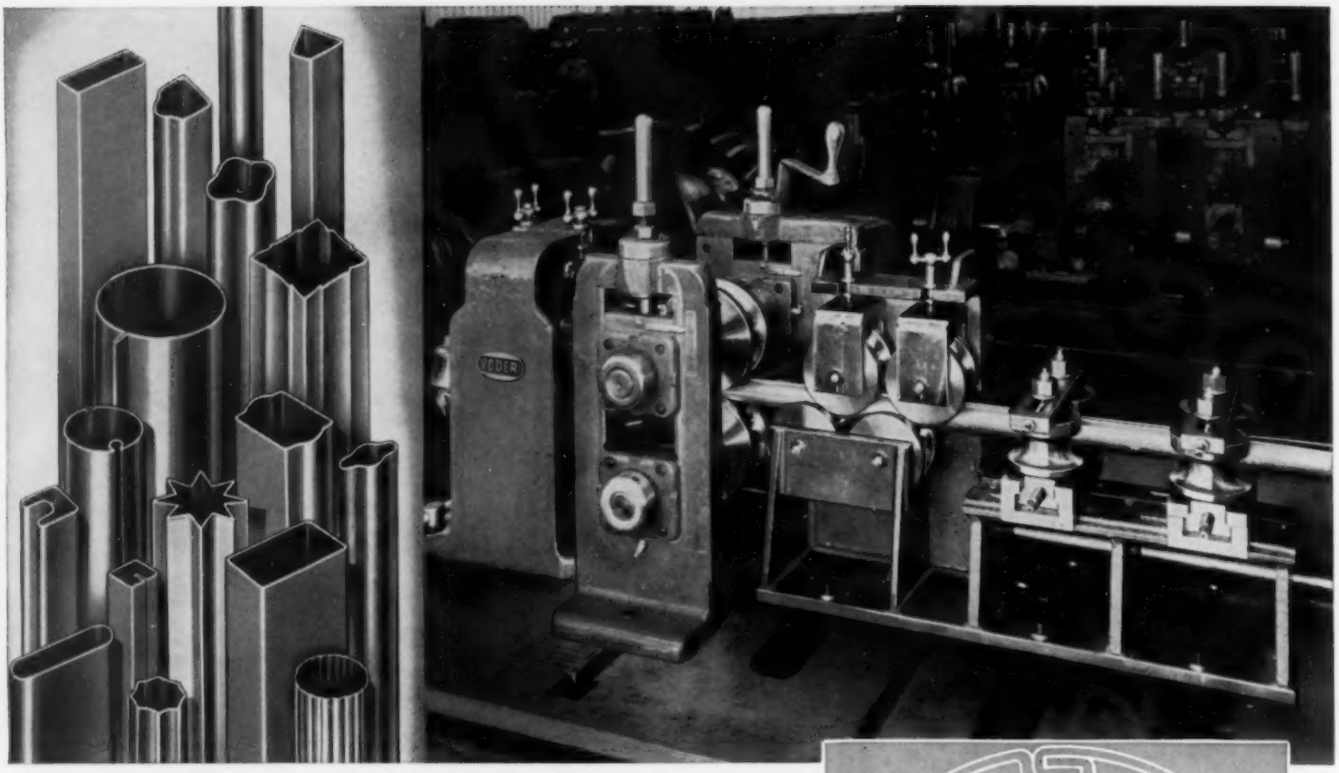
LEC-TROL-FEED Systems are installed faster and at lower cost than ever before. All units are preassembled in standard 30 ft. rigid-track sections. That means fewer joints, fewer hangers. Expansion sections are needed only at building joints. No extra rain shields needed for outdoor applications.

You gain maximum safety with LEC-TROL-FEED Systems because current carrying bus bars are almost completely enclosed – minimizing danger from contact with current-carrying bus. Trolley Safety-Slot covers are removable–parts easily accessible.

Additional features include compactness for close vertical stacking, maximum ruggedness, maximum leakage distances, proved aluminum bus bars. Track power capacity 300 amperes, AC or DC; trolley ratings up to 300 amperes.

For complete information, write or ask for LEC-TROL-FEED Bulletin.
Electric Service Works,
Delta-Star Electric Division,
H. K. Porter Company, Inc.,
Philadelphia 32, Pa.

HKP
ELECTRIC SERVICE WORKS
DELTA-STAR ELECTRIC DIVISION
H. K. PORTER COMPANY, INC.



Lock-Seaming attachment at exit end of forming machine.

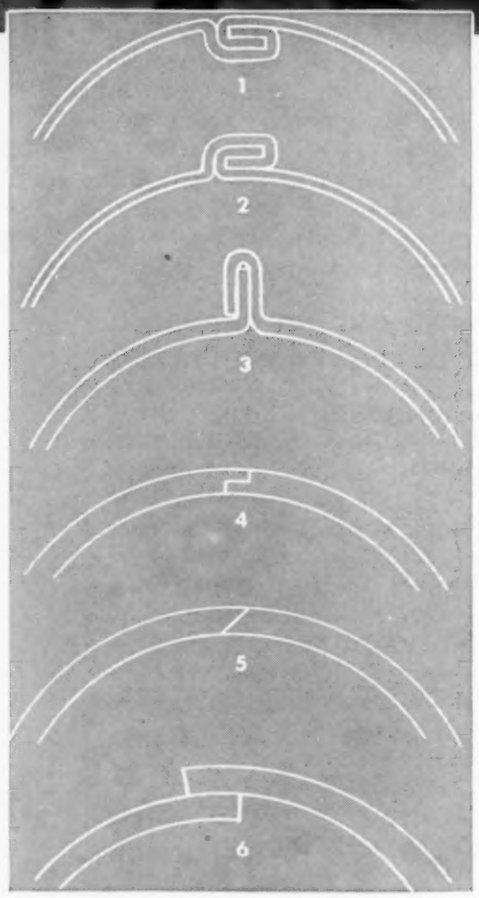
COLD ROLL FORMING TUBULAR SHAPES

Among the wide variety of things you can make on a Yoder Cold Roll Forming machine are round, square, oval, rectangular and other tubular shapes, such as illustrated at left above. The seams may be open, lapped, butted, dovetailed, interlocking, etc.—as indicated in Figures 1 to 6 at the right.

Millions of feet of such unwelded tubular shapes are made from coiled strip for conductor pipe, bedsteads, lamp stands, window channel, wiring raceways, carrying rods, etc. Production ranges from 20,000 to 50,000 feet per day, with only one operator and a helper.

Yoder offers you the cooperation of their engineering staff for designing and adapting their cold roll forming machines, auxiliaries, and tooling, for the low cost production of structurals, mouldings and trim, panels, tubular and other shapes, to meet individual needs.

The Yoder book on Cold Roll Forming is a complete, illustrated text on the art and the equipment needed for performing a variety of operations which can be combined with cold roll forming, at little or no extra labor cost. A copy is yours for the asking.



THE YODER COMPANY
5495 Walworth Avenue **Cleveland 2, Ohio**

ENGINEERING **YODER** MANUFACTURING

COLD ROLL FORMING MACHINES

PIPE AND TUBE MILLS (ferrous or non-ferrous)

ROTARY SLITTING LINES

screw - down drives, edging mill drives, manipulators and manipulator rack drives. The second system will supply 1800 SSU oil at 100 F at the rate of 40 gpm to front and rear main mill runout tables. The third unit, which will lubricate a No. 600 shear drive and shear depressing pull back table, will supply 40 gpm of 1500 SSU oil at 100 F.

PLACES ORDER FOR PIPE STRAIGHTENER

Blaw-Knox Co. has received an order from the National Tube Division of United States Steel Corp. for a multi-cycle type pipe straightener for installation at the Ellwood City Works.

To be used for precision straightening of cold drawn tubing, the new No. 3 machine will handle pipe and tubing up to 4½ in. in diameter. The unit's six rolls are arranged so the workpiece is given a series of straightening cycles in a single pass.

CF&I COMPLETES NEW PUEBLO OPEN HEARTH

The Colorado Fuel and Iron Corp. has completed a new open hearth furnace at its Pueblo, Colo., plant.

This new No. 17 furnace is of modern design and has a capacity of 230 tons per heat. It is the largest furnace in the Pueblo open hearth shop. Construction was carried on simultaneously with improvements that were being made to the other sixteen furnaces which will increase the annual rated steel capacity of the Pueblo plant from 1,485,000 to 1,800,000 tons.

One of the major improvements has been the conversion of the furnaces to a double ladle heat practice which permits the steel to be tapped into two ladles rather than the one ladle used previously.

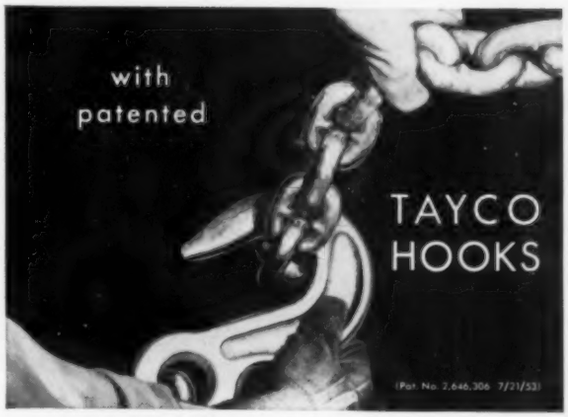
Meetings

▲ The thirty-sixth meeting of The Galvanizers Committee will take place at the Drake Hotel, Chicago, Ill., April 25–26, 1957. This committee, sponsored by the American Zinc Institute, is composed of technical and operating men of the sheet and pipe galvanizing divisions of the steel industry.

TM

factory made

ALLOY SLINGS



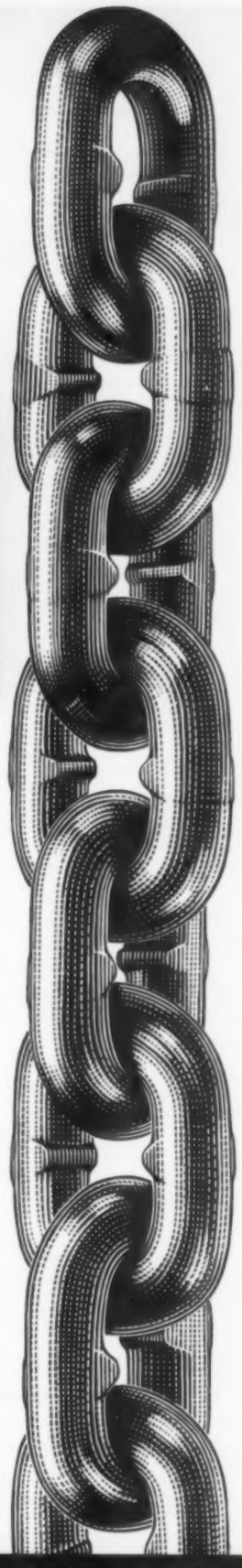
PLUS

GAMMA RAY
QUALITY CONTROL
on master, joiner and end links,
are the

toughest, safest,
most economical
you can use!

Rugged TM factory made Alloy Sling Chains rate ace high in industry for safety, long life and economy. Taylor's rigid standards, plus Tayco Hooks . . . Gamma Ray Quality Control . . . Controlled Atmosphere Heat-Treating of popular sizes and Taylor's special analysis alloy steel are a few of the reasons why! Investigate the many other advantages of using these famous slings now!

Call your DISTRIBUTOR today for all the facts and specifications!

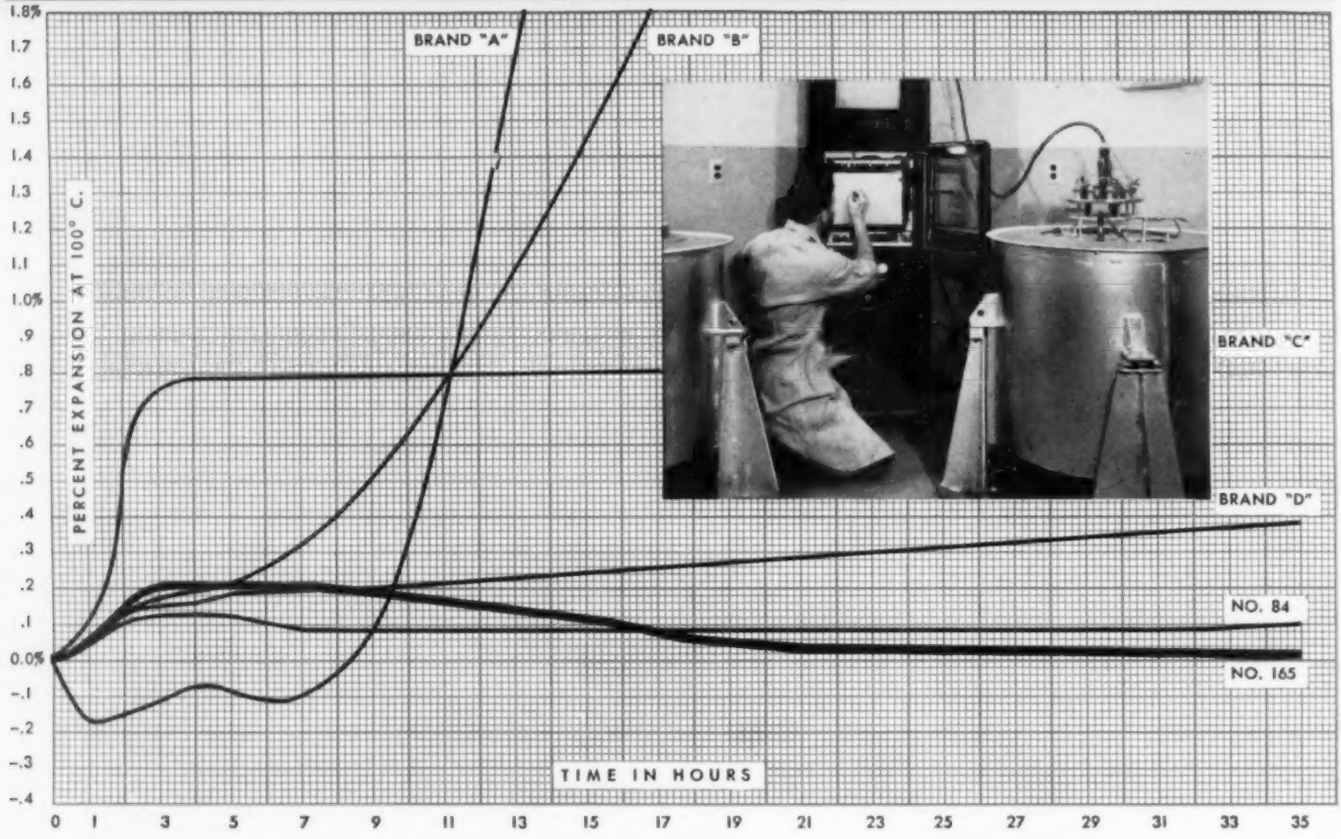


TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

S. G. TAYLOR CHAIN CO., INC.
A complete line of quality chain
Main office and plant — Hammond, Indiana
Eastern sales office and plant
3505 Smallman St., Pittsburgh, Pa.

DILATOMETER VOLUME STABILITY TEST

"SOAK AND SWELL" CHART shows why Permanente 165 Ramming Mix gives longest-life furnace bottoms



HYDRATION—reaction with water—during the heat-up period usually causes swelling of rammed magnesia bottoms. Leading ceramic engineers believe that as little as 0.3% expansion indicates damaging hydration, shorter bottom life.

To measure these minute expansions, Kaiser Chemicals Research developed the sensitive electronic instrument shown above. This device, called a dilatometer, can accurately measure and record expansions of less than 0.01% and maintain a constant temperature within $\pm 0.5°C$.

Dilatometer Traces Charts

For the test charted above, equal size blocks freshly prepared from each of six well-known ramming mixes were placed in a common heating chamber and attached to the recorder.

The chamber was then heated to just below the boiling point of water with the atmosphere held at 100% relative humidity to create forced hydration conditions. Finally, the samples were allowed to soak for 35 hours to simulate hydration conditions which a mix may encounter in the deeper regions of a bottom.

As you can see in the chart, Permanente 165 shows virtually no signs of expansion . . . proof that it resists hydration significantly better than any other ramming mix tested. (Permanente 84 Hot Patching Mix runs a very close second.)

Research Aids Bottom Performance

Permanente 165's outstanding resistance to hydration is an excellent example of how Kaiser Chemicals Research is working to give you furnace bottoms that last longer, need fewer repairs. Why not let your Kaiser Chemicals Sales Engineer provide research, design and installation assistance to help you take advantage of this superior ramming mix?

Call or write Kaiser Chemicals Division, Dept. R7422, Kaiser Aluminum & Chemical Sales, Inc., at any of the addresses listed below:
PITTSBURGH 22, PA. . . . 3 Gateway Center
HAMMOND, IND. . . . 518 Calumet Building
OAKLAND 12, CALIF. . . . . 1924 Broadway

Kaiser Chemicals

Pioneers in Modern Basic Refractories

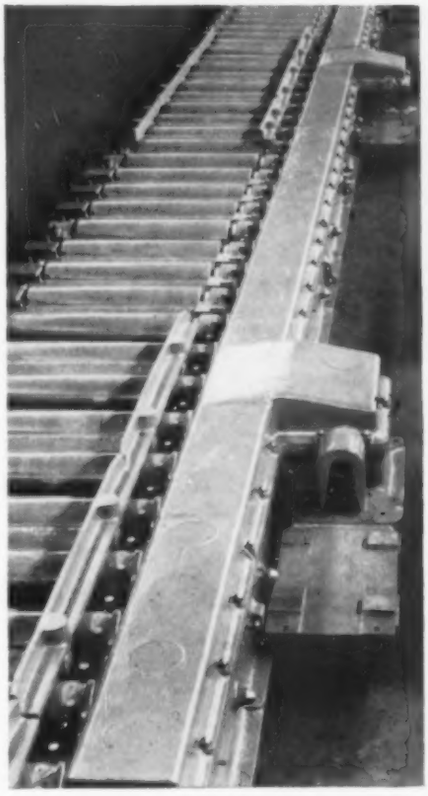
Refractory Brick and Ramming Materials • Castables & Mortars
Magnesite • Periclase • Deadburned Dolomite

THE BROOKS OIL CO.

Lube-Engineering News

A REPORT ON THE DIFFICULT LUBRICATING PROBLEMS OF INDUSTRY

93% SAVING IN MILL TABLE LUBRICATION COSTS REPORTED BY LEADING STEEL PRODUCER



A leading steel producer recently went through a series of corrective measures to improve lubrication of mill tables. They went from circulating oil system to pressure grease system and finally to automatic spray system.

In the spray system, they used Brooks Klingfast and reported a saving of 93% in lubricant cost. They do not attribute the saving to the change in equipment, as various lubricants were tested. Klingfast offered the greatest reduction in lubricant cost for the application.

Records indicate a 35% decrease in man hours spent on this lubrication job, and 65% less maintenance delays due to improved lubrication. Klingfast has proved itself against adverse conditions of mill scale, water and high temperatures. Savings in maintenance costs were coupled with increased production.

For full information, write for Engineering Letter 73IS.

NEW COLOR FILM AVAILABLE TO LUBE-ENGINEERING GROUPS

This new 30 minute 16 mm motion picture, in full color, with sound, shows a number of tough lubrication jobs. It pictures and describes the research, manufacturing and quality control methods that enable Brooks lubricants to "stand up" under severest service.

It's available to any supervisory or engineering group interested in lubrication problems. No charge, of course—we're glad to have you see it. Just call or write any of our offices and tell them you want to borrow "The Brooks Oil Story."

CIRCULATING OIL SYSTEMS REQUIRE LUBRICANTS THAT WITHSTAND SEVEREST SERVICE CONDITIONS

Dust, dirt, water and metallic contamination present extremely difficult problems for circulating oil system lubricants—in steel mills, forging and press shops, cement plants and many other industries. Lubricating compounds must withstand constant contact with contamination, readily dissipate such foreign matter and maintain quality for continued service.

Brooks Leadolene and Klingfast are compounded to meet such severe conditions. These products have served industry since the early 30's and have broken many records. Companies in the United States and Canada have obtained 5, 10, 15 and 20 years of continued service from these lubricants. For complete facts, see your Brooks representative or write for Engineering Letter 86IS.

THE BROOKS OIL CO. 81st YEAR 1876 1957

THE BROOKS OIL COMPANY

EXECUTIVE OFFICES AND PLANT—CLEVELAND, OHIO
EXECUTIVE SALES OFFICES—928 RIDGE AVENUE, PITTSBURGH 12, PA.
OFFICES AND WAREHOUSES IN PRINCIPAL CITIES

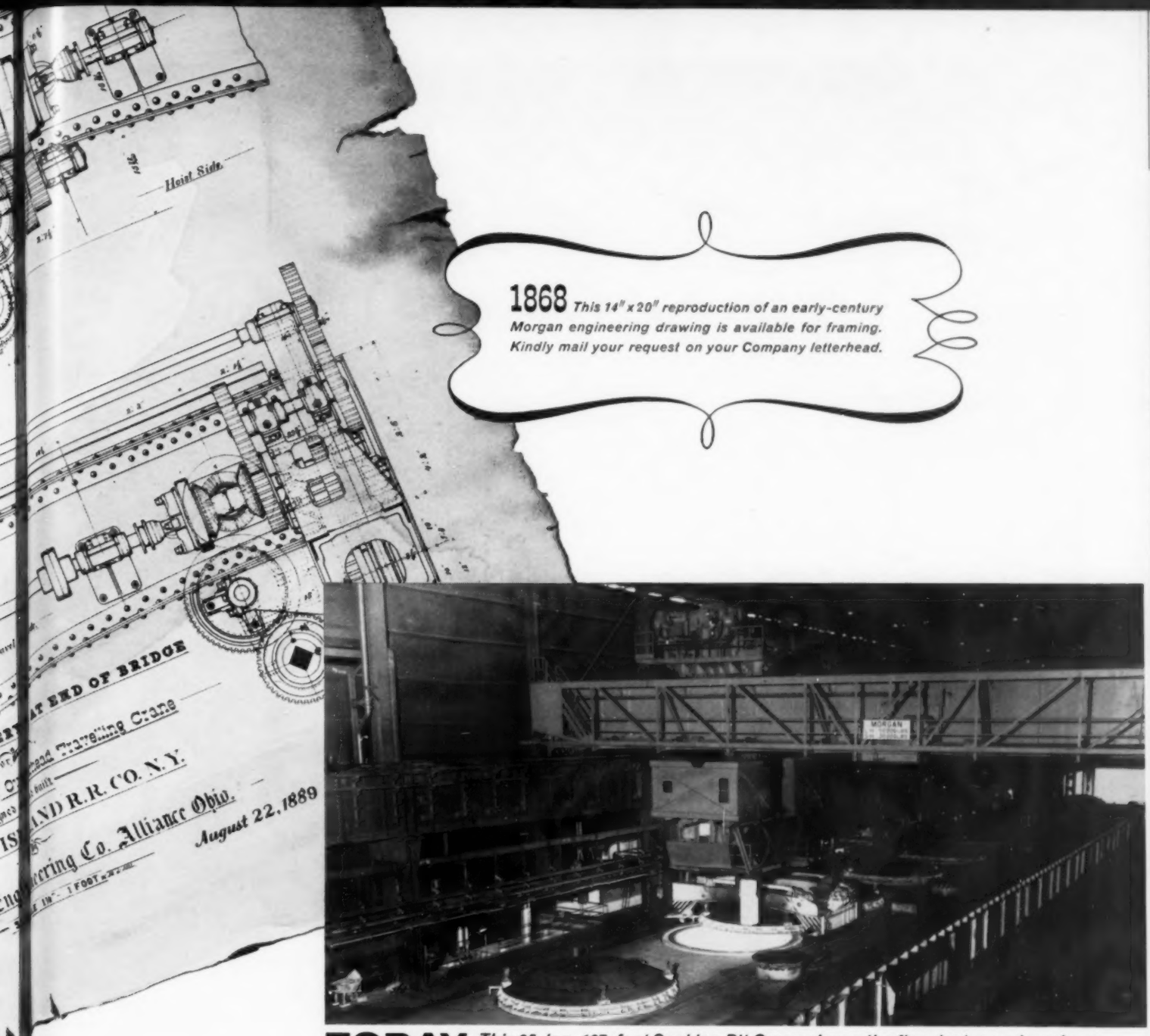
U.S.A.
CANADA
CUBA—S.A
EUROPE

You save the most

QUALITY in every detail is a

Since 1868, the advanced design and quality construction of Morgan cranes and mill equipment have been the highest standard in the industry.

Today, through research and the development of improved equipment features—modern and efficient production methods—Morgan continues to offer the steel industry equipment that is



1868 *This 14" x 20" reproduction of an early-century Morgan engineering drawing is available for framing. Kindly mail your request on your Company letterhead.*

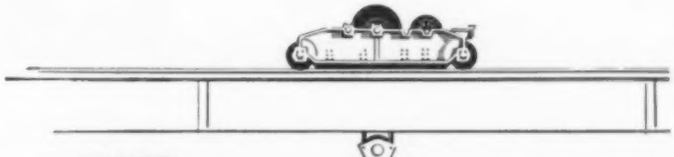
TODAY *This 25-ton, 107-foot Soaking Pit Crane shows the fine design and workmanship, the attention to details which has always typified Morgan Cranes.*

by buying the best...

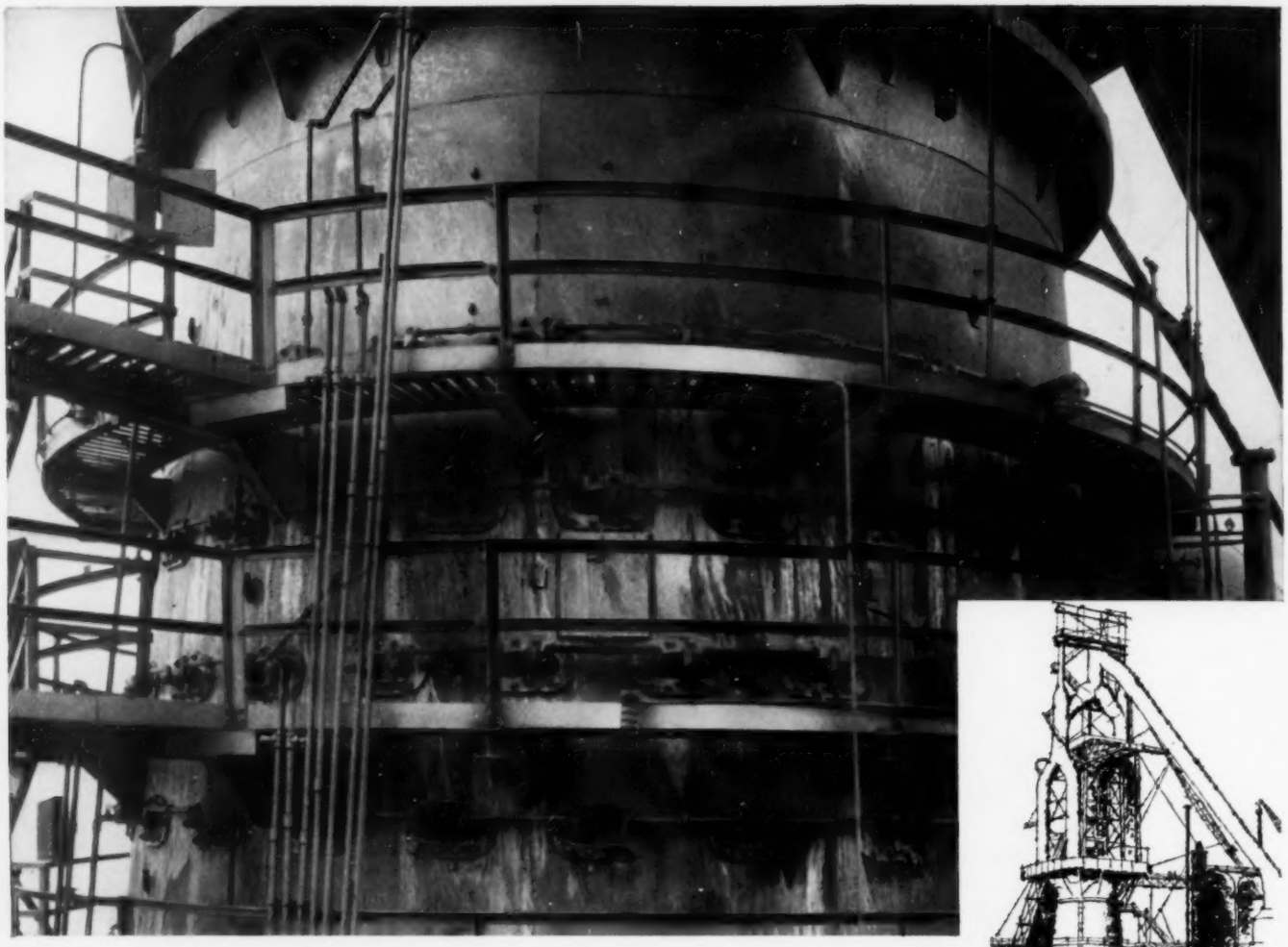
tradition with Morgan cranes and mill equipment

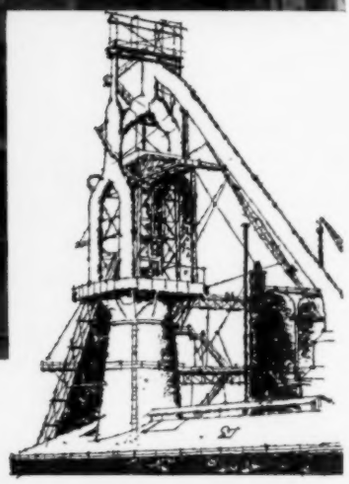
less costly to operate and maintain. Let our representative show *you* how to save the most by buying the best . . . MORGAN!

Overhead electric traveling cranes, gantry cranes, open hearth special cranes, plate mills, blooming mills, structural mills, shears, saws and auxiliary equipment.



THE
MORGAN
ENGINEERING CO. *Alliance, Ohio*





Why Airco 78E electrodes were selected to weld blast furnace "R"

A large eastern steel producer planned to build the giant blast furnace designated "R". Welding – with its obvious advantages of speed and economy – was naturally selected as the best method of construction.

But – which electrode would best do the job? These were the factors involved in making a decision:

(1) Quality of weld deposit. Welds had to be leakproof to contain the 15 lb. psi pressure in the vessel. **(2)** High ductility and tensile strength were of prime consideration. **(3)** An all-position electrode was absolutely essential.

The Airco 78E electrode answered all these qualifications. Therefore, it was the logical choice. A total of 13,500 pounds of Airco 78E electrodes were used to weld the structure.

In building a blast furnace – or rebuilding an engine housing – Airco's Electrode Pocket Guide can help you take the guess work out of selecting the right electrode for the job. This 44-page booklet contains neatly condensed descriptions, applications and procedures – plus charts and graphs – for using the complete Airco line of electrodes.

It's free. Write Airco, at the address below. Request Catalog 1318.

VISIT OUR BOOTH 334 WELDING SHOW

AT THE FRONTIERS OF welding PROGRESS YOU'LL FIND . . .

AIRCO®

Offices and dealers in most principal cities

AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated, New York 17, N. Y.

On the west coast – Air Reduction Pacific Company

Internationally – Airco Company International

In Cuba – Cuban Air Products Corporation

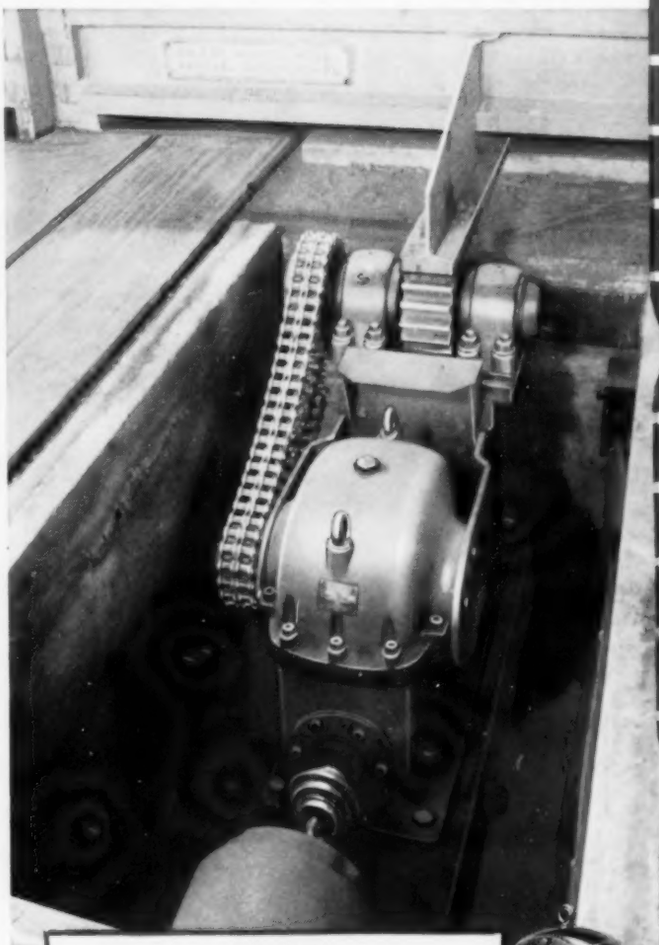
In Canada – Air Reduction Canada Limited

Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** – industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** – carbon dioxide, liquid-solid ("DRY-ICE") • **OHIO** – medical gases and hospital equipment • **NATIONAL CARBIDE** – pipeline acetylene and calcium carbide • **COLTON** – polyvinyl acetates, alcohols, and other synthetic resins.

Arrange high-ratio speed reduction in least space from

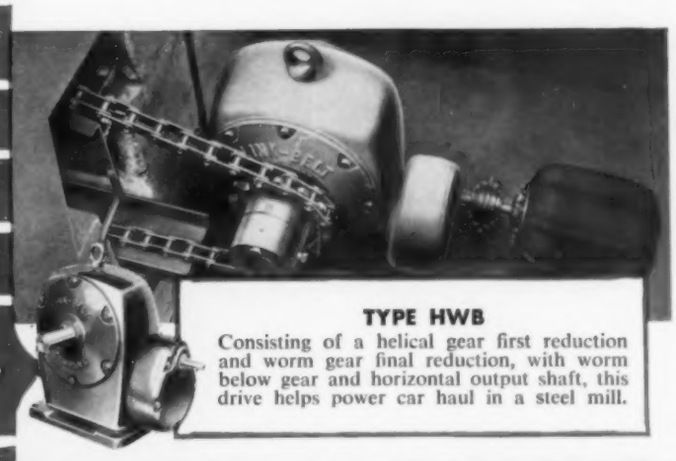
these 4 and 15 more

LINK-BELT Worm Gear Drives



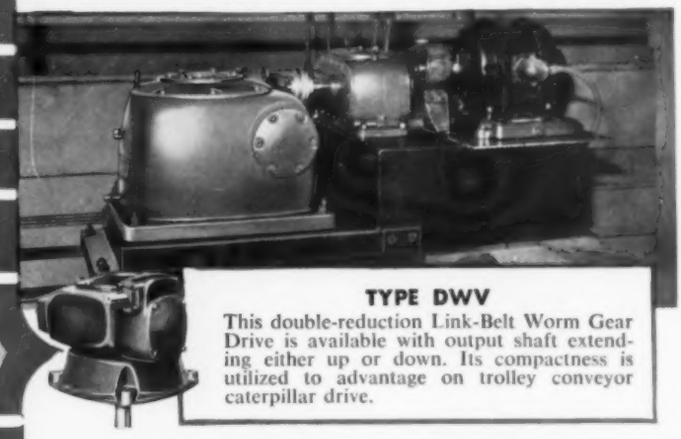
TYPE WB

Link-Belt Worm Gear Drive, part of mechanism for moving cars in and out of annealing furnace, has a single reduction with worm below gear and horizontal output shaft. Link-Belt makes all components for complete drives, including roller chain and bearings used here.



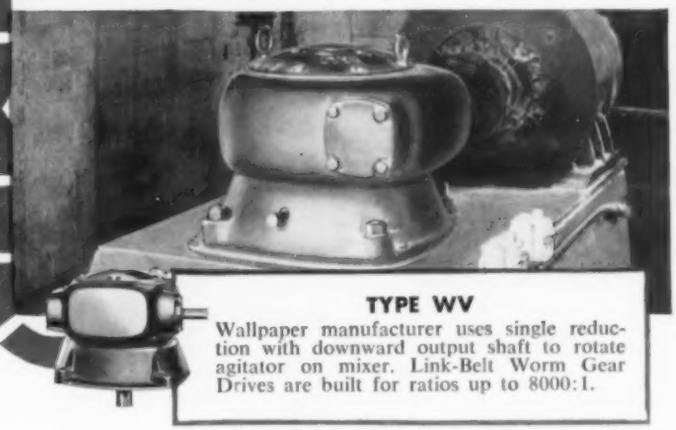
TYPE HWB

Consisting of a helical gear first reduction and worm gear final reduction, with worm below gear and horizontal output shaft, this drive helps power car haul in a steel mill.



TYPE DWV

This double-reduction Link-Belt Worm Gear Drive is available with output shaft extending either up or down. Its compactness is utilized to advantage on trolley conveyor caterpillar drive.



TYPE WV

Wallpaper manufacturer uses single reduction with downward output shaft to rotate agitator on mixer. Link-Belt Worm Gear Drives are built for ratios up to 8000:1.

ADD to basic compactness the application flexibility offered by 19 types — and you'll find the perfect mating of speed and need in the complete Link-Belt line of Worm Gear Drives. For selection guidance and full data, ask your nearest Link-Belt office for copy of 80-page Book 2324-A.

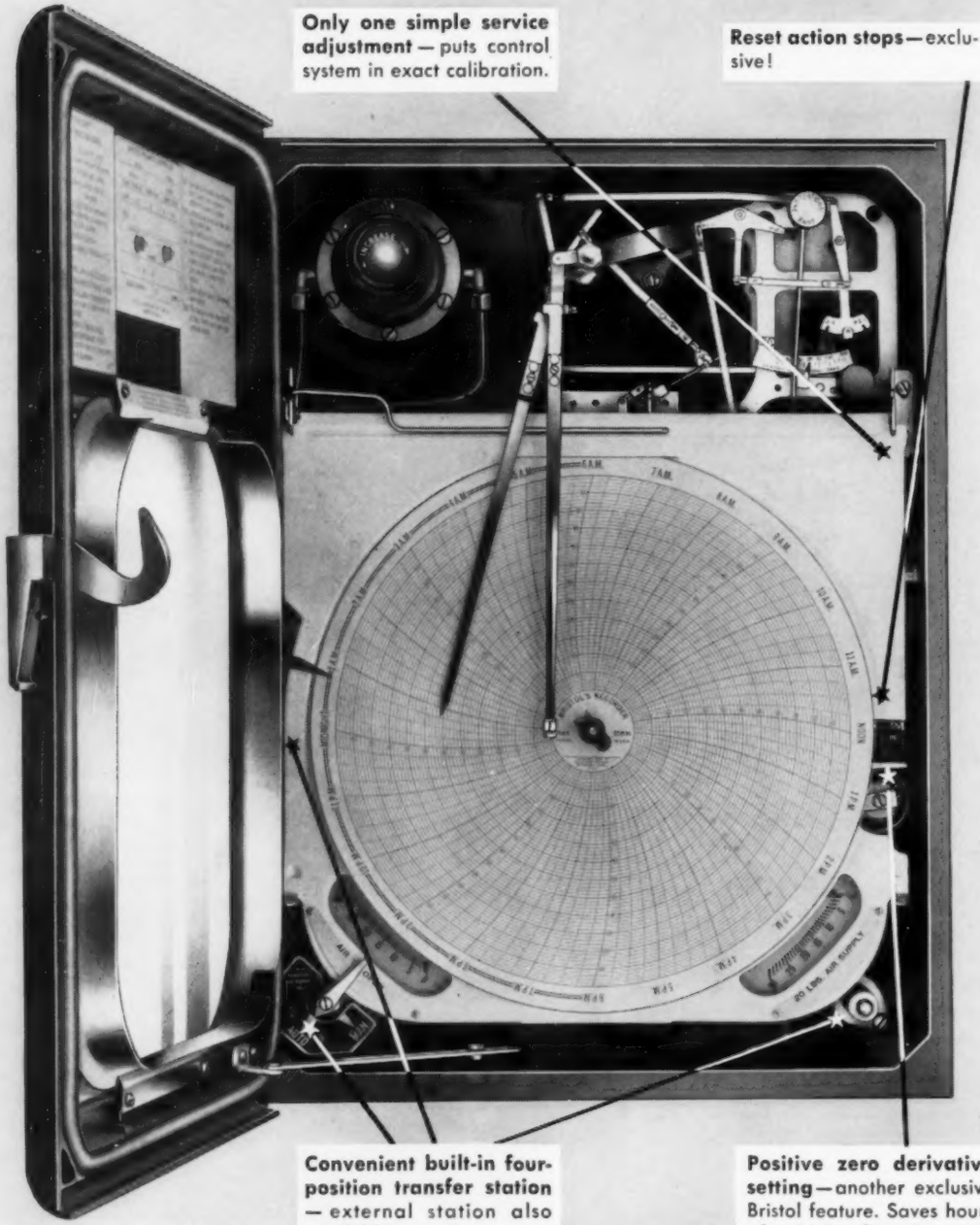
LINK-BELT

ENCLOSED DRIVES

14,307

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

Are you sure you


Only one simple service adjustment — puts control system in exact calibration.
Reset action stops—exclusive!
Convenient built-in four-position transfer station — external station also available.
Positive zero derivative setting—another exclusive Bristol feature. Saves hours of initial adjustment time for difficult processes.

MADE IN MODELS FOR THESE CONTROL MODES:

1. **Fixed narrow band** (on-off).
2. **Proportional**—to 100% and to 30%.
3. **Reset with wide band**—rates 0.1 to 10 or 1 to 300 repeats per minute. Proportional band to 400%.
4. **Derivative** (rate)—Derivative time 0.2 to 20 min., plus zero derivative setting.
5. **Reset plus derivative**—proportional band, reset rate and derivative time as shown above.

WILL HANDLE THESE CONTROL PROBLEMS:

1. Cascaded control
2. Selective control
3. Ratio control
4. Time-program control
5. Pneumatic transmission.

are getting the best in pneumatic controllers?

Before you buy another controller check these advantages of the new Bristol Series 500 Free-Vane* Pneumatic Controller

FINEST MEASURING ELEMENTS

Bristol Series 500 Pneumatic Controllers are equipped with precision Bristol measuring elements—the widest selection of high-quality measuring elements available with any line of control instruments. You'll find models for control of: **temperature, pressure, vacuum, draft, absolute pressure, liquid level, flow, humidity, density, pH, and a large number of other variables measurable with electronic potentiometers and bridges.**

The sustained, predictable performance of Bristol measuring elements is one reason why you'll find more Bristol recording pressure gauges in use *than all other makes combined.* The new, completely linear Bristol Dual-Filled Vapor Pressure Measuring Element used in Series 500 Thermometer Controllers is the first really big advance in this field of measurement in 25 years. The Bristol Absolute Pressure Element, available in ranges as low as 0-6 mm of mercury absolute, also leads in its particular field. These are just a few of many examples of Bristol leadership in the development and improvement of measuring elements.

ADVANCED CONTROL SYSTEM FEATURES

Many features *found on no other pneumatic controller* assure better control with the Bristol Series 500: Reset action stops on reset models prevent loss of control due to prolonged deviation from set point; true zero derivative setting (on derivative models) can save hours of initial adjustment time; easy shift to wider proportional band (½ to 200% or 1 to 400% on wide band models) *without recalibration.*

BEST MAINTENANCE RECORD

One simple adjustment puts a Series 500 controller in exact calibration.

Basic simplicity, accurate design, closely held manufacturing tolerances make this single adjustment all that's necessary—even after complete disassembly and reassembly with replacement parts.

Bristol Series 500 Controllers on the job in new modern processing plant. Absolute pressure, steam flow, and liquid levels are variables controlled here.

This practically "built-in" calibration is typical of the foresight and engineering planning that make the Series 500 the easiest pneumatic control system on the market to service. Cut-and-try methods are eliminated. No special maintenance skills are required. All parts are completely interchangeable. The result: a truly superlative maintenance record in thousands of industrial plants.

NATION-WIDE SERVICE

Series 500 Controllers are backed up by the kind of service a quality product requires. The facilities of the main factory, four strategically-located branch factories, and factory-trained service engineers operating out of 44 principal cities across the United States and Canada are on call whenever and wherever needed to help you get the most out of your Bristol Pneumatic Controllers.

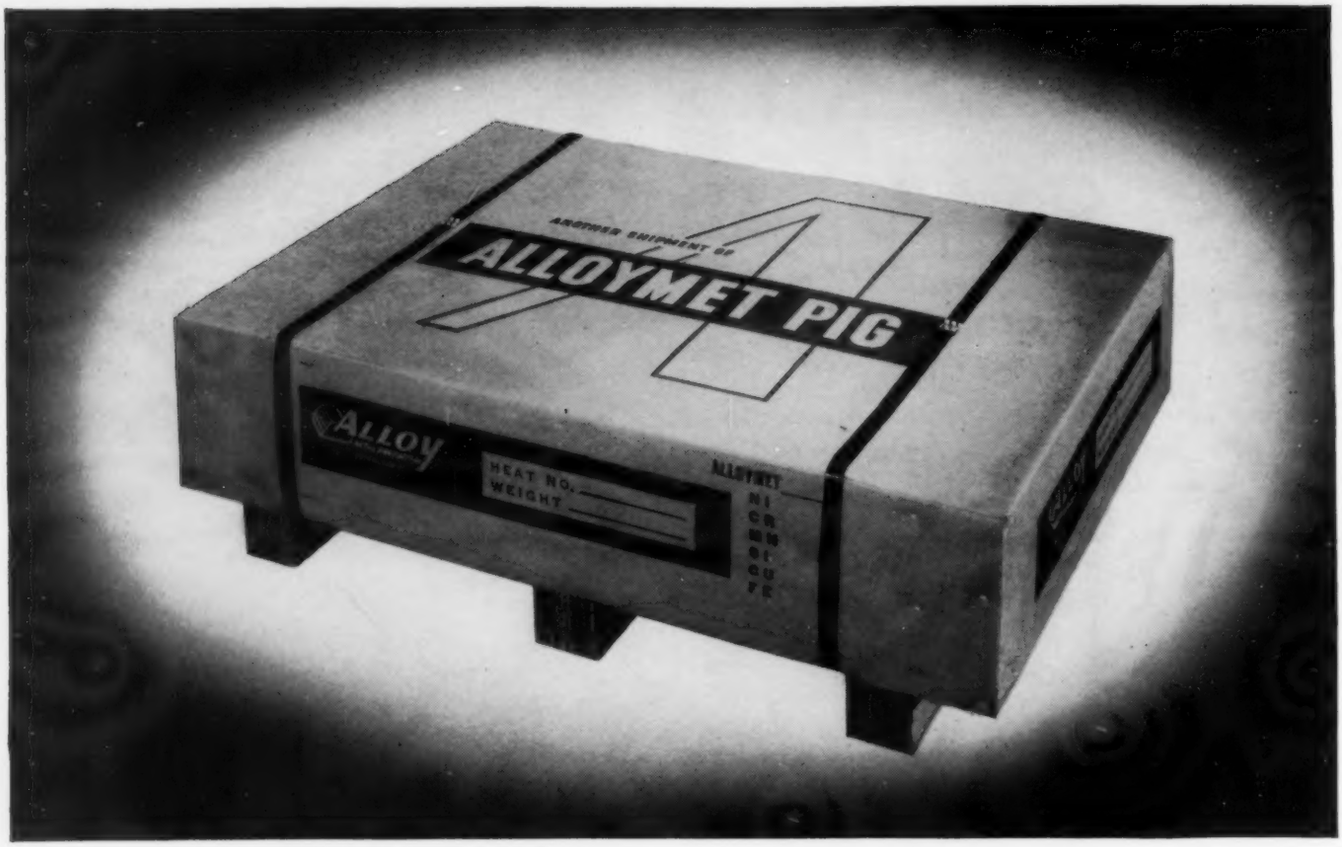
GET COMPLETE INFORMATION

. . . on the Bristol Series 500 Pneumatic Controller before you buy another instrument! Fully described in Bulletin A130. Write: The Bristol Company, 123 Bristol Road, Waterbury 20, Conn. 6.76

*T.M. Reg. U. S. Pat. Off.

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



NEW "BOX LUNCH" of NICKEL ALLOY

speeds feeding of electric furnaces

26 nickel alloy pigs, each weighing about 50 pounds, travel inside this new palletized package. Weight and certified analysis are in plain view at all times. All fiberboard, it can go into the electric furnace "as is." It weighs only ¼ as much as a wooden pallet. Saves on transportation costs. Discourages pilferage. Speeds handling.

Users are already enthusiastic about this new nickel alloy package. Like the quality product it contains, it serves as a further example of the exacting care Alloy Metal Products, Inc., exercises in every phase of the production of alloy metals.

If you are still using scrap for your alloy requirements, ask us about Alloymet pig of certified analysis.

ALLOY
METAL PRODUCTS, Inc.
PHONE 6-2561 • TELETYPE DV 588
(FORMERLY A DIVISION OF **ALTER COMPANY**)
ROCKINGHAM ROAD
DAVENPORT, IOWA

World's largest producer of secondary nickel alloys of certified analysis

Personnel News...

James W. Kinnear, Jr., was named executive vice president of United States Steel Corp.'s Tennessee Coal & Iron Division. Mr. Kinnear, vice president—operations at TCI since November 1, 1955, succeeds **John Pugsley,** who became assistant executive vice president—accounting for U. S. Steel. Beginning his career with U. S. Steel in 1923, Mr. Kinnear was employed as a laborer at Homestead Works in the Pittsburgh district. After numerous advancements, he became assistant manager of operations—Pittsburgh district in 1940, serving in that capacity until 1947, when he left the corporation to become president of Firth-Sterling Steel & Carbide Co. He returned to U. S. Steel in 1951 as assistant to vice president—manufacturing. From September 1, 1951, until March, 1955, he was general superintendent, Edgar Thomson Works. He served as assistant vice president—engineering at U. S. Steel from March, 1955, until he moved to Birmingham.

William E. Crouch, Jr., was named vice president—operations of United States Steel Corp.'s Tennessee Coal & Iron Division, succeeding **Mr. Kinnear. John W. Price, Jr.,** succeeds Mr. Crouch as general superintendent of U. S. Steel's Edgar Thomson Works, and **Clifford B. Brundage, Jr.,** replaces Mr. Price as assistant general superintendent at the corporation's Duquesne Works.

Mr. Crouch began his employ with U. S. Steel in 1933, as a clerk at Homestead Works. He served in various capacities at that operation, rising to the rank of division superintendent at the time he was transferred to the Edgar Thomson Works as assistant general superintendent in 1952. Since March 1, 1955, he has served as general superintendent, Edgar Thomson Works. Mr. Price joined U. S. Steel at the Homestead plant in 1937, as a metallurgical observer. He became assistant chief metallurgist in 1942. In 1945, he went to the Pittsburgh offices as bureau manager of the railroad material metallurgical division and in 1947, became assistant metallurgical engineer for railroad and commercial forging products. He returned to Homestead in 1950, as assistant to the general superintendent. In 1952, he became assistant division superintendent, slabbing and plate division, and in 1954, was appointed superintendent of the division. In 1955, he was transferred to Duquesne Works as assistant general superintendent. Mr. Brundage joined U. S. Steel in 1937 at Duquesne Works as an observer in the metallurgical department. He was assigned to the rolling mill department in 1941 and was made assistant to the division superintendent, rolling mills in 1945. After becoming assistant superintendent of No. 5 bar mill in 1948, Mr. Brundage was made assistant to the general superintendent in 1952. He remained in this position until 1953, when he became assistant division superintendent, rolling. Prior to his new appointment he had been division superintendent, maintenance.

Robert H. Howard has been named assistant to the director, general planning, Kaiser Steel Corp. In his new position Mr. Howard will assist the director in coordinating the planning of capital expenditures throughout the company's operations. He was formerly supervisor of general planning and has been associated with the department since 1949.

D. R. Mathews, formerly open hearth superintendent at Alan Wood Steel Co., has been named general superintendent of primary production in charge of operations at the Open Hearth, Coke & Chemicals, and Blast Furnace Departments. Mr. Mathews originally joined Alan Wood in 1939 as a junior melter. He then served in various supervisory capacities until his appointment as superintendent of the Open Hearth Department in 1942. **J. H. Cain** has been appointed as Open Hearth Superintendent to succeed Mr. Mathews. Mr. Cain joined the company in 1948 as open hearth general foreman, and in 1950 was made assistant superintendent of the Open Hearth Department.

Dr. William A. Reed, process engineering head of Republic Steel Corp.'s research laboratory, will direct Republic's study of applications of nuclear energy in the steel industry. **Leonard R. Stone** has been assigned the responsibility of heading the Nucleonics Department with special emphasis on isotope research studies in steel processes. **Dr. Robert P. Petersen,** who had been director of nuclear research of the company, has resigned to accept a position as president of Applied Research, Inc. The firm does research and development

J. W. KINNEAR, JR.

W. E. CROUCH, JR.

J. W. PRICE, JR.

C. B. BRUNDAGE, JR.

J. E. BALTZELL

RUSSELL MARTIN

HARRY HOLIDAY, JR.

W. J. DIEHL

work on scientific and technical problems for industrial companies and the government.

James E. Baltzell has been named superintendent of the maintenance shops department at the Middletown, Ohio, Works of Armco Steel Corp. Other changes announced at Middletown include: **Russell Martin** who becomes superintendent of the assigned maintenance department; **Harry Holiday, Jr.,** who was appointed manager of the blast furnace department; and **William J. Diehl,** promoted to superintendent of the coke plant and transportation and labor departments of the Hamilton plant of the Middletown Works. Mr. Baltzell joined Armco as a mechanical engineer in 1935. He was promoted to assistant to the assistant superintendent of the maintenance shops in 1950, and continued in that assignment until the present. Mr. Martin became an engineering trainee in the hot strip mill department at Middletown in 1930. Five years later he transferred to the maintenance department. In 1952, he was made assistant superintendent of the assigned maintenance department and held that position until his recent promotion. Mr. Holiday joined Armco as a trainee in 1949. Two years later he became a fuel study man in the engineering department. He was placed on special assignment in 1952, and was later assigned to the blast furnace department. In 1954, he was transferred to the blast furnace of the Hamilton plant as assistant to the superintendent. It was from this position that he was promoted. Mr. Diehl began his Armco career in 1932. After serving as a heater helper, assistant yardmaster, and brick inspector, he became superintendent of transportation and labor at the Hamilton Plant in 1941. He held that assignment to the present.

John F. Holt was named superintendent of the Coke and Coal Chemical Works at United States Steel Corp.'s Fairless Works, succeeding **D. C. Coleman** who has joined the Wilputte Coke Oven Division of Allied Chemical and Dye Corp. as director of operations and development.

Richard A. Geuder has been named general manager —marketing, Reliance Electric and Engineering Co., and **Carl V. Gregory** has been named sales manager. Mr. Geuder has been general sales manager for the past year, and Mr. Gregory has been manager of district sales since coming to the home office from the Pittsburgh District in 1954.

Paul Cain has been appointed director of industrial engineering for Armco Steel Corp. At the same time, **Malcolm Reed, George G. Davis, Mark S. Scheibert** and **Carl Funk** were appointed supervising industrial engineers.

Mr. Cain started with Armco's Columbus Division in 1923. He served two years as an inspector at the Armco Coal Mines at Nellis, W. Va., and became a time study man in 1925. In 1926, he was transferred to the Ashland, Ky., Works' production standards department.

In 1929, he moved to the company's Butler, Pa., Works as supervisor of production standards. In

PAUL CAIN

1932 and 1933, he spent fifteen months in England on special assignment for Armco International Corporation. He returned to Armco's general office in 1934 as a staff engineer, and in 1935 was sent to the Ashland Works as supervisor of production standards.

J. Eric Heyworth, Thomas P. Arbogast and **Richard P. Schrift** have been named assistant superintendents of departments at the Cleveland, Ohio, steel plant of

Exclusive with the Heroult:

Operating Mechanism Independently Supported

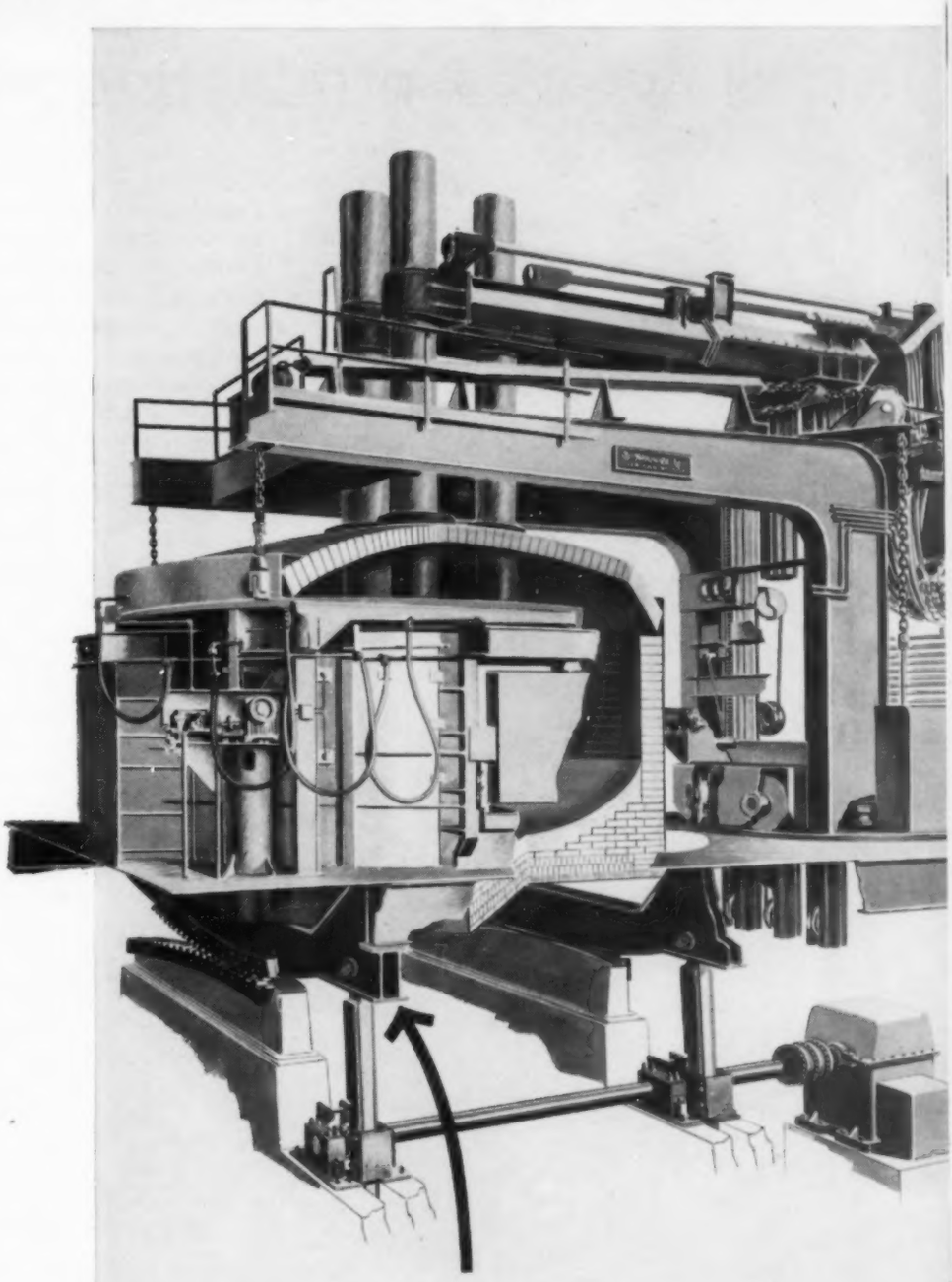
In Heroult's specially designed **new** furnaces the operating mechanism is located on the tilting platform, supported on rockers completely separate from the cage shell. In the event of shell warpage due to overheating, the mechanism remains unaffected and efficient production continues free from maintenance delays.

The independently supported operating mechanism which contributes to lower operating costs, and helps cut maintenance outlays to a fraction of former rates, is only one of the advanced design exclusives offered by the **new** Heroult for increased production efficiency. There are four others ready to operate on your behalf:

1. **Flat-bottom shells, for simplified relining jobs and good bath temperature distribution.**
2. **Water-cooled skew back roof ring, eliminates need for special roof refractories.**
3. **Cage-type shell construction, minimizes shell distortion and facilitates replacement of damaged shell plates.**
4. **100% mechanical operation, for reliability and ease of maintenance.**

There is a wide range of **new** Heroult Furnaces with shell sizes from 7′0″ up, and with capacities from 6000 to 400,000 pounds. You can obtain them with non-magnetic induction stirring equipment, top charge, door charge, and special duplexing. Non-ferrous furnaces are also available.

The pioneers and leaders in this field for 51 years, Heroult specialists in electric furnaces can help you select and install the equipment best suited to your current and future needs. Get in touch with our nearest contracting office—today—for complete information.



USS

AMERICAN BRIDGE DIVISION
UNITED STATES STEEL CORPORATION, GENERAL OFFICES:
525 WILLIAM PENN PLACE, PITTSBURGH, PA.
Contracting Offices in New York, Philadelphia, Chicago, San Francisco, and other principal cities.
United States Steel Export Company, New York

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

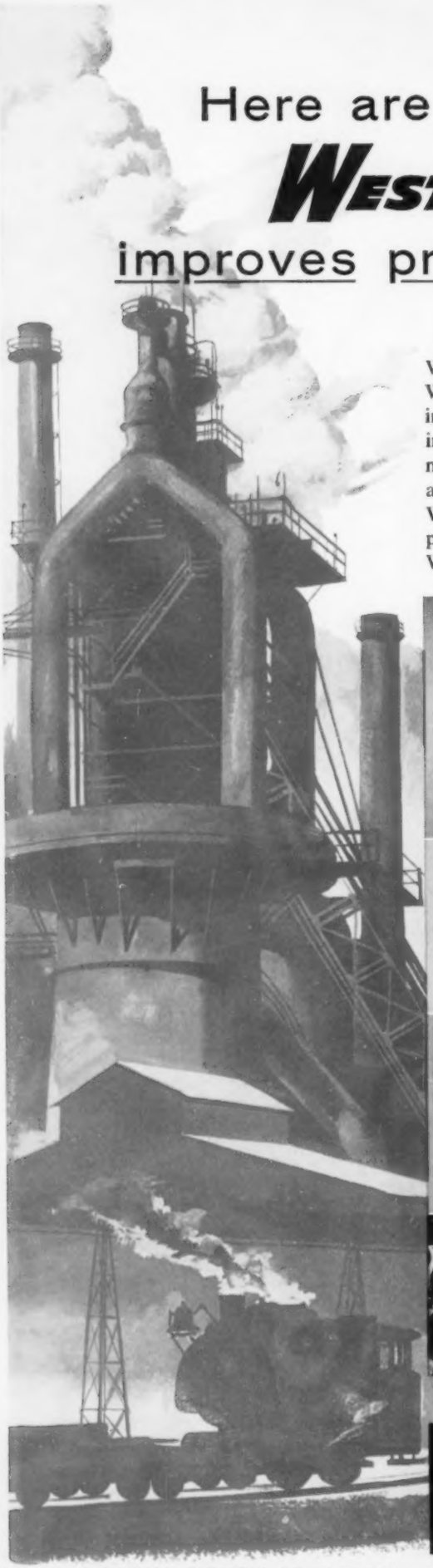
Heroult
ELECTRIC MELTING FURNACES

UNITED STATES STEEL

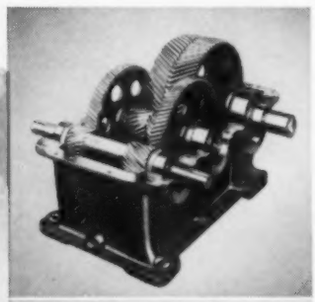
Here are 4 of 1001 ways

WESTERN GEAR

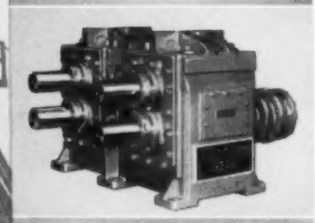
improves production efficiency!



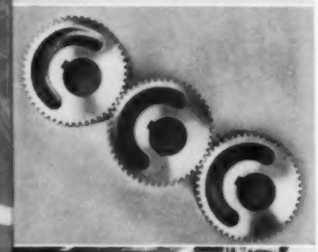
Working in close cooperation with the steel industry for 68 years, Western Gear has achieved a backlog of experience and know-how of inestimable value to the steel mill engineer. Take advantage of this intimate knowledge of America's basic industry. Ask for one of our steel mill application engineers to consult with you relative to the diverse and specialized gears and gear products necessary to the steel industry. We invite, without obligation on your part, inquiries concerning any power transmission or gear applications you are considering. Write: General Offices, Western Gear, P.O. Box 182, Lynwood, California.



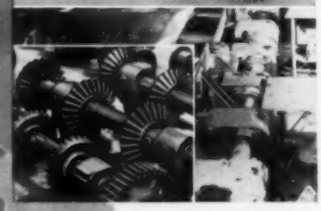
Speed Reducers Wherever you find efficient steel production, you are apt to find the mill relying on Western Gear to provide its speed reducer needs. Capacities of these units range to 10,000 HP. As a result of years of successful service to the industry, Western Gear speed reducers are utilized on main mill drives and auxiliary drives in steel mill centers everywhere. Western Gear reducers are also used on cranes, for trolley, bridge and hoist drives as well as all types of conveyors.



Pinion Stands Western Gear has enjoyed the unique experience of supplying pinion stands to steel mills throughout the nation. Capacities range to 5000 HP. Conservative design with compact, rigidly constructed gear cases, precision cut gearing and carefully selected bearings are all a must in the production of a Western Gear mill pinion stand.



Precision Elliptical Gears Here's a totally new concept of generating elliptical gears achieved after extensive research by Western Gear technicians. It provides a precision method that makes possible greater life . . . smoother operation. The new Western Gear method insures proper gear tooth profile, minimizes tooth to tooth spacing tolerances . . . produces each tooth normal to the true elliptical pitch line.



Miter Gears Because day after day, Western Gear continues its fact finding study of the steel industry, it has won wide recognition for many improved applications of gears. A good example is this gearing made for mill table rolls. To insure internal control of all heat treating processes to steel mill standards, Western Gear operates its own heat treating and metallurgical departments.

"The difference is reliability" • Since 1888

5629

WESTERN GEAR *Corporation*

ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.) SEATTLE AND HOUSTON—REPRESENTATIVES IN PRINCIPAL CITIES

Republic Steel Corp. Also, **Michael Palivoda** was named master mechanic and **Joseph H. Snayd,** assistant master mechanic at the plant. Mr. Heyworth was promoted to assistant superintendent of the mechanical department. He was previously master mechanic at the plant; Mr. Arbogast, formerly master mechanic at the strip mill, was promoted to assistant superintendent of the mechanical department for the strip mill; and Mr. Schrift, who was turn foreman in the inspection department, was promoted to assistant superintendent of inspection and conditioning.

Wilfred D. MacDonnell has been appointed assistant to the executive vice president on special assignments of National Steel Corp. Mr. MacDonnell had spent his entire previous working career with Bethlehem Steel Co., advancing to the position of assistant manager of the company's plant at Johnstown, Pa., prior to joining National Steel. He joined Bethlehem in the open hearth department of the Lackawanna, N. Y., plant in 1934. He was made assistant superintendent of the No. 1 open hearth department in 1937, assistant to the general manager of the Lackawanna plant in 1947, and general superintendent of the Steel division in 1948. He was transferred to the Johnstown plant in 1949, where as assistant general manager he had direct supervision of the coke oven, blast furnace and open hearth departments, of various rolling mills and of the metallurgical department.

Malcolm A. Jones was appointed plant engineer at the Fontana, Calif., steel plant of Kaiser Steel Corp. He was formerly assistant chief engineer at the Lackawanna, N. Y., plant of the Bethlehem Steel Co.

John F. Hoffman has been appointed assistant superintendent of the electric weld pipe mill at Kaiser Steel Corp. Mr. Hoffman came to Kaiser in 1951 as a design engineer on the staff of plant engineering. In 1955 he was named staff engineer, responsible for the tin mill, 86 in. mill, 110 in. plate mill, roll shops, specialty manufacturing and warehouse. Prior to his new position, he was tubular engineer for the electric weld pipe mill. Prior to joining Kaiser, Mr. Hoffman was superintendent of Welded Products Co. for three years. Previous to that, he was employed by Crucible Steel Co. of America and Pittsburgh Bridge and Iron.

Bertram A. Kline has been elected assistant vice president and sales manager of the Birdsboro Steel Foundry & Machine Co. He was formerly sales manager of the company's steel castings and miscellaneous machinery division, and general advertising manager—a position he held since 1953. Mr. Kline has been associated with Birdsboro in a sales capacity for more than 30 years.

Frederick J. O'Reilly was appointed to the newly created position of general manager of manufacturing for National Electric Products Corp. Mr. O'Reilly was formerly works manager of National Electric's plant at Elizabeth, N. J.

Ernest S. Griswold has been appointed chief product engineer of the cutting tool division of Pratt & Whitney Co., Inc. Mr. Griswold succeeds **John S. Gibson** who has become chief engineer of the Illinois Tool Works.

T. L. Nabors has been named assistant chief combustion engineer for Republic Steel Corp.'s southern steel district. He was formerly a combustion engineer at the Gadsden, Ala., plant of Republic Steel.

John L. Mangan has been appointed manager—industry sales for General Electric Co.'s Gas Turbine Department. He joined GE in 1945 and was placed on the engineering test program. A year later he entered the company's Turbine Division, steam turbine design section, and in 1948 became associated with the division's turbine sales. In 1952 he was named Turbine Specialist for the mid-states district, with headquarters in St. Louis, Mo. Mr. Mangan was named sales manager-industrial sales of the Gas Turbine Department in 1955 and retained that position until this recent appointment.

Paul E. Busby has been appointed director of research for Heppenstall Co. He succeeds **Dr. R. B. Corbett,** who was transferred to the Midvale-Heppenstall Co. Mr. Busby joined the company in 1955 as a research assistant, and was made assistant director of research in 1956.

Clark E. Hague was named director of engineering for the North American Mfg. Co.'s newly formed Hydraulic Controls Division. Mr. Hague was formerly

W. D. MAC DONNELL **M. A. JONES** **J. F. HOFFMAN** **B. A. KLINE**

N. M. MC GRANE

T. J. MC LOUGHLIN

G. L. STANCLIFF, JR.

J. G. FRISCHKORN

an engineer with Askania Regulator Co., and more recently president of Hague Regulator Co. **Hugh N. Helm,** application engineer in the Hydraulic Controls Division, was associated with Mr. Hague in the Hague Regulator Co., and previously worked with Mr. Hague as an engineer for Askania Regulator Co. Mr. Helm has also been a combustion engineer with Republic Steel Corp. and with Youngstown Sheet & Tube Co. Manager of the new division is **Harvey E. Neville** who has been with North American for some time. Previously he was general works manager of Cleveland Pneumatic Tool Co.

Norman M. McGrane has been appointed vice president of Western Precipitation Corp. Mr. McGrane has been with Western Precipitation for more than 30 years. Most recently he has served as chief technical engineer for Cottrell, Multiclone, CMP and Dualaire lines. In addition to his engineering duties, Mr. McGrane is also a member of the executive committee and a director.

Thomas J. McLoughlin has become affiliated with the M. H. Detrick Co., as a consultant for their open hearth and steel mill departments. Mr. McLoughlin is a retired operating executive of the U. S. Steel Corp., and former chairman of the American Iron and Steel Institute Technical Committee on open hearth steelmaking.

G. L. Stancliff, Jr., has been appointed vice president and general manager of Askania Regulator Co.

John G. Frischkorn has been appointed assistant sales manager of the Cleveland Tramrail Division of The Cleveland Crane & Engineering Co. Mr. Frischkorn has had sixteen years' experience with Cleveland Tramrail as design engineer for overhead materials handling equipment. He also was with the Euclid Crane & Hoist Co. for five years where he served in engineering and sales capacities, including sales manager. For the past year he has been district sales manager covering W. Va., Pa., N. Y., and eastern Canada.

Edward Gerstenschlager has been appointed manager of production engineering of The Babcock & Wilcox Co.'s Boiler Division. Mr. Gerstenschlager joined B & W in 1933 as a chemist at Barberton, Ohio. He was made a service engineer in 1937 and worked in both the Cincinnati, Ohio, and New York districts before being promoted in 1950 to project manager in New York and Barberton.

Addison Davidson, Jr., has been appointed Eastern district sales manager for Femco, Inc. Mr. Davidson has been employed by Femco, Inc., for eight years in the capacity of sales engineer.

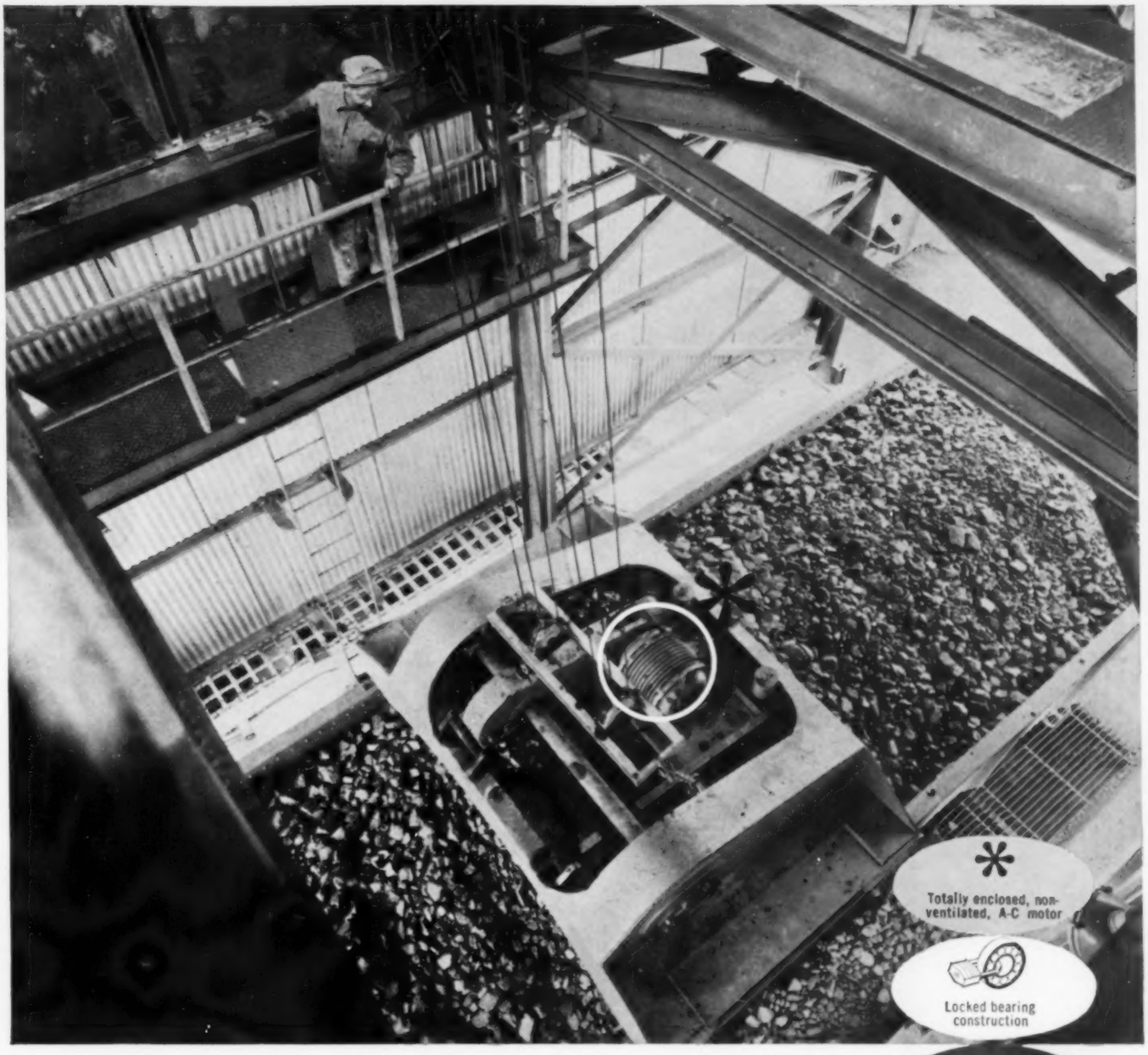
John R. Lowey, formerly assistant superintendent of the mechanical department of Republic Steel Corp.'s Cleveland, Ohio, plant has been named superintendent of the mechanical department.

Arnold Sherman has been appointed product engineer of the Peerless Electric Co.'s Electronics Division. Mr. Sherman has been with the Electronics Division since its formation at Peerless Electric in 1954.

H. C. Wallace, district manager of Air Reduction Sale Co.'s Louisville, Ky., sales office was appointed assistant regional sales manager of the Southern Region. **A. C. Pease,** assistant sales manager, Louisville, succeeds Mr. Wallace as district manager. Mr. Wallace has been with Air Reduction since 1929 and has held various posts at the Louisville office. He was appointed assistant sales manager in 1936 and became district manager in 1947. Mr. Pease, with the company since 1947, originally joined Airco's Chicago district. In 1951, he moved to Kansas City as assistant sales manager and a year later to Louisville in the same capacity, the position he held at the time of his present appointment.

Charles E. Pretzinger has been appointed Pacific Coast district manager of Pangborn Corp. He has served as district sales engineer with Pangborn in the Pacific Coast office since 1948 and was previously associated with Link-Belt Co. as an industrial engineer.

Winthrop B. Reed, formerly manager—industrial sales, General Steel Castings Corp., has been promoted to manager—Eastern sales, with offices at Eddystone, Pa. Mr. Reed will be in charge of all sales covering railroad specialties, industrial castings and iron and



On this punishing assignment...

Louis Allis motors sturdily absorb severe physical abuse

Providing the power for a car-shaker is a punishing assignment for an electric motor. It's a tough test, calling for physical characteristics not usually demanded of electrical rotating equipment. The slightest flaw in mechanical design or construction may result in destruction of the motor.

Here's where Louis Allis special-motor engineering talent met and solved a tough materials-handling problem. Here's where really *solid* industrial construction and quality features pay off in dollar-saving uninterrupted material movement. Features like special bearing construction eliminate end play . . . take heavy loads . . . lengthen bearing life. They'll pay off in your plant, too.

Ask a Louis Allis sales engineer to survey your materials-handling motor and drive needs. He's a motor expert and will make sound recommendations, without obligation, of course.

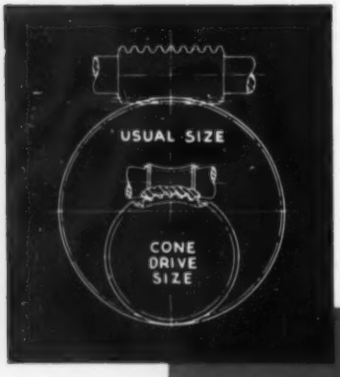
Get the Louis Allis "Consolidated Catalog," Bulletin 105. Contact your nearby Louis Allis District Office, or write The Louis Allis Company, 450 East Stewart Street, Milwaukee 1, Wisconsin.

LOUIS ALLIS

LA-114

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE-SPEED DRIVES

for concentrated power



. . . CONE-DRIVE gearing has no equal.

You can pass an amazing amount of power through a set of Cone-Drive gears.

Want to cut product size? Cone-Drive will give you a more compact gear train with reserve load capacity.

Want to boost power output and hold size? That's easy with Cone-Drive gears. They'll carry two, three, and four times the load of cylindrical worm gearing.

Why? In Cone-Drive gears, the load isn't concentrated on a small area per tooth or on just one or two teeth at a time. Cone-Drive's exclusive double-enveloping principle distributes the load over a lot of teeth and over more area on each tooth.

It cuts the unit loading the same way a pair of snowshoes supports a heavy man.

Ask for Bulletin CD-400 for complete details.

CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

C. D. GABOR

J. E. HOVIS

JACK GRANT

JOSEF REICHMAYR

steel rolls at the company's Eddystone and Avonmore, Pa., locations. He joined General Steel Castings in 1946.

Charles D. Gabor has been named assistant chief engineer of Harbison-Walker Refractories Co. He has been in the company's Engineering Department since 1941. Most recently he has been a project engineer.

James E. Hovis has been appointed manager of the Industrial Furnace Division of the Gas Machinery Co. He previously managed sales engineering for steel mill furnaces. In his new position, Mr. Hovis will direct the sales, as well as engineering, manufacturing and installation of all Gasmaco furnaces. He came to Gas Machinery in 1954 from The Bloom Engineering Co.

Jack Grant has been appointed administrative assistant to the president of Pennsylvania Engineering Corp. Mr. Grant has been serving as sales engineer and will continue in this capacity as well.

Josef Reichmayr, formerly with the Vereinigte Osterreichische Eisen-und-Stahlwerke A. G. (VOEST) steel plant in Linz, Austria, has joined Pennsylvania Engineering Corp. as planning and design engineer. While at VOEST he was assistant manager of the blast furnace department and later joined their engineering and planning department.

E. H. Sangwine was appointed manager of Kaiser Aluminum & Chemical Corp.'s alumina and caustic chlorine production facilities now under construction near Gramercy, La. **Walter H. Bast** has been named to succeed Mr. Sangwine as works manager of the company's Chalmette, La., reduction plant.

Thomas F. Gallagher has been appointed Chicago district sales manager, for the Laclede-Christy Division, H. K. Porter Co., Inc. Mr. Gallagher, a sales engineer for Laclede-Christy since 1946, previously was in Buffalo, N. Y.

Tom R. Morrison has been appointed direct factory representative in Del., Md., and central Pa. for the Columbus McKinnon Chain Corp. and its Chisholm Moore Hoist Division. In addition, **Arthur H. Luchs** has been appointed direct factory representative in northern Calif. and Nev. for the chain products line of the Company.

Hugh D. O'Rourke was appointed Chicago district sales manager for Research-Cottrell, Inc. Mr. O'Rourke was formerly a plant engineer with General Motors Corp. and also held various positions in the sales department of Westinghouse Electric Corp. He came to Research-Cottrell in 1955 as a sales engineer.

Robert F. Schall has been named sales manager of the Kelman Electric & Manufacturing Co., a recently acquired subsidiary of the I-T-E Circuit Breaker Co. Mr. Schall has been associated with I-T-E since 1951, and most recently served as manager of equipment sales in its Switchgear Division. Prior to joining I-T-E, he had been general sales manager of the Roller-Smith Co.

E. Herbert Rose has been appointed chief beneficiation engineer in the Freyn Department, Engineering & Construction Division, Koppers Co., Inc. Mr. Rose was formerly resident engineer for the Tennessee Coal & Iron Division of U. S. Steel Corp.

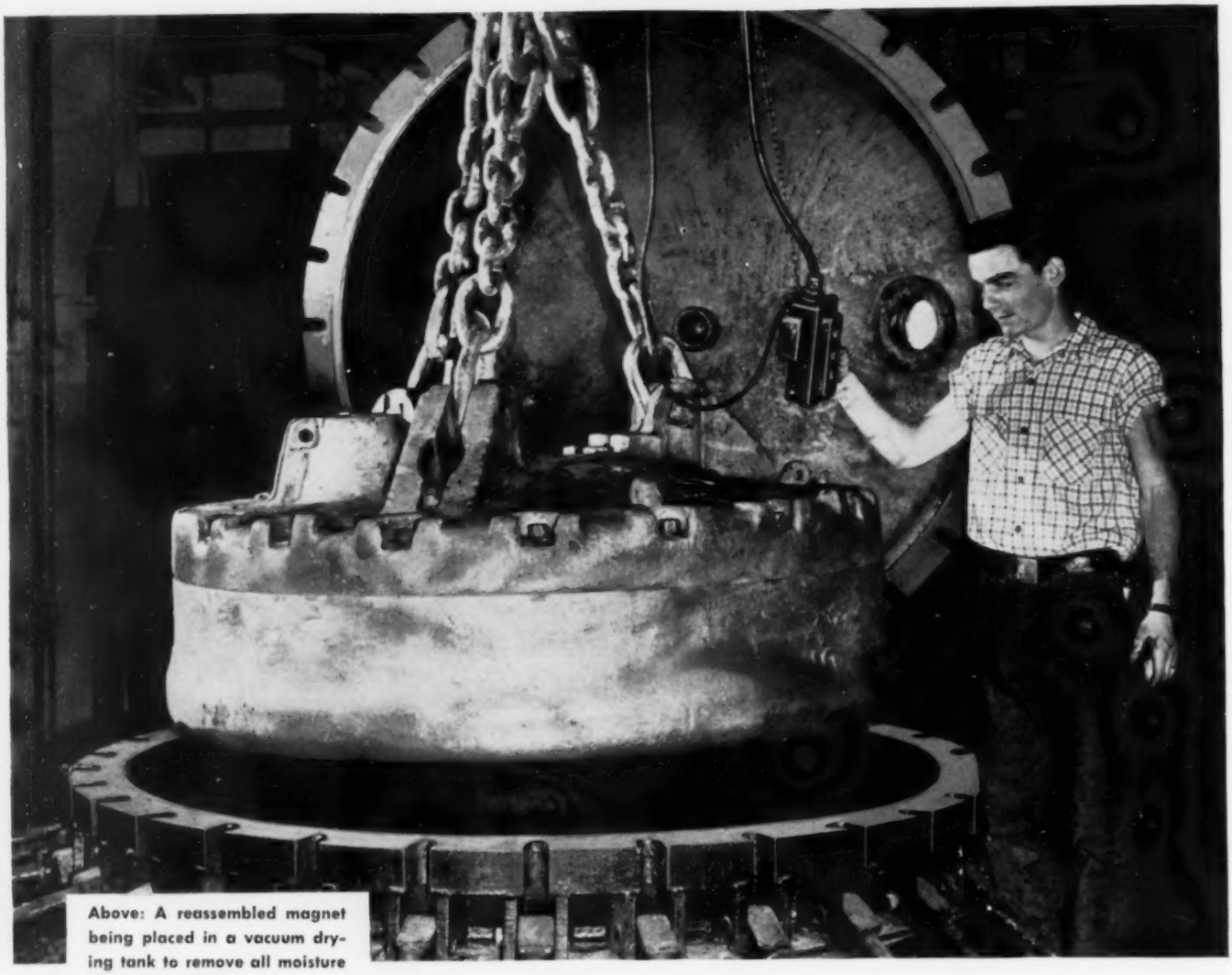
Robert L. Brown was appointed sales manager of gasoline and LP-Gas powered industrial trucks and **Charles E. Howard** was named sales manager for electric powered trucks and truck attachments for the Yale & Towne Manufacturing Co. Mr. Brown was previously manager of electric truck sales. Mr. Howard assumes the electric truck post from the position of manager of attachment sales for the Division.

Gordon N. Dow has been appointed general sales manager of Leschen Wire Rope Division, H. K. Porter Co., Inc. Mr. Dow has been successively territory salesman in the Detroit, Mich., area and sales manager of the Chicago, Ill., District.

Obituaries

Joseph F. Joy, 73, founder of the Joy Manufacturing Co., died February 19.

L. A. Umanski, well-known steel plant electrical engineer with General Electric Co., died April 3.



Above: A reassembled magnet being placed in a vacuum drying tank to remove all moisture before compounding.

Below: Magnet case being opened on a large capacity boring mill. Capsule-type magnet coils must also be opened by cutting on this mill.

NATIONAL

is equipped for high speed, high quality

Lifting Magnet Repairs

National's lifting magnet department has the equipment, manpower and the "know-how" to restore your lifting magnets to original specifications — and to improve them by redesign which takes full advantage of recently developed techniques and materials. And the new, modern equipment in this department not only insures high quality but speeds production.

For details on what these facilities can mean to you, just call your nearby National field engineer or drop us a line.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

TRADE MARK

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION— REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

NOW
BILLET MILL OPERATORS
IDENTIFY
POSITIVELY!

TOP CUTS
MIDDLE CUTS
BOTTOM CUTS

Border design identifies positively, even with partial impression. "T" in triangle is used for top, "M" in cloverleaf for middle, "B" in circle for bottom. Available in three styles—standard single and double end, and 4-section stamp.

Mecco SAFETY
BILLET MILL CUT LETTER STAMPS

Write for Data Sheet 653.

Mecco SAFETY MARKING TOOLS
M.E.CUNNINGHAM CO.
1041 CHATEAU STREET, PITTSBURGH 33, PA.

A PRODUCT OF THE MARKING DEVICE INDUSTRY

BEWARE of RUST and SCALE in Hydraulic Systems

"It takes only one or two flakes of rust passing through precision pumps and valves to scratch surfaces enough to reduce the efficiency of these components. A scratch on a pump piston can cause an excessive amount of slippage resulting in horsepower loss and overheating. . . ."

Reprinted from APPLIED HYDRAULICS April 1956—page 74

Filter Out Ferrous Grit with

FERROFILTER®

Magnetic Separators

Get rid of iron particles circulating in fluid power lines and you'll reduce maintenance costs, parts replacement and down time.

Low pressure FERROFILTERS 1" and under made this way

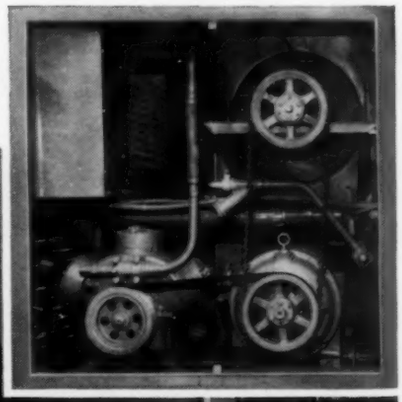
Other low pressure models to 3" pipe size.

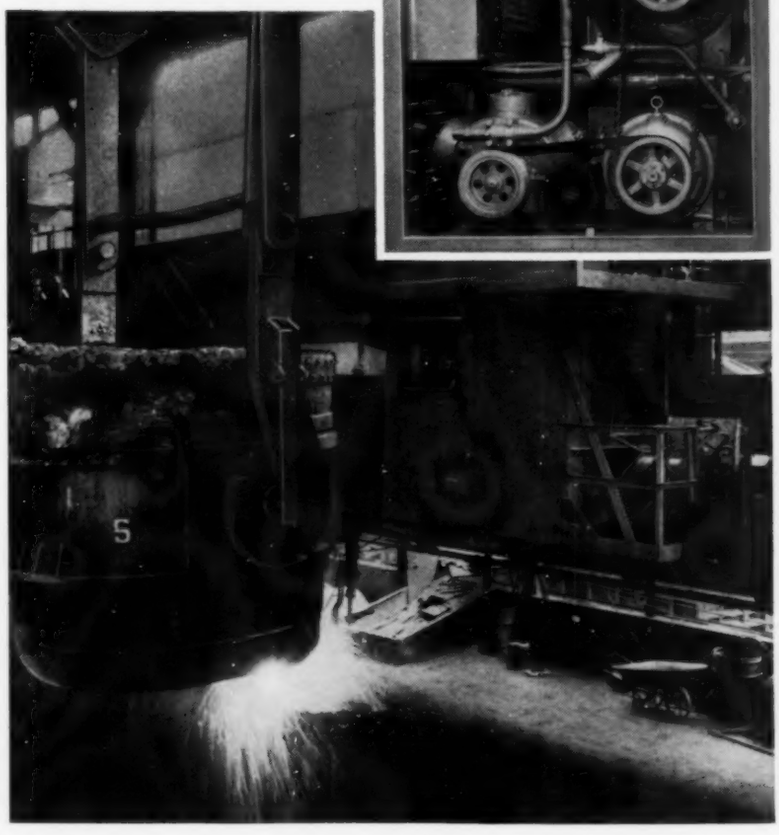
High pressure models also available.

Send for BULLETIN PM-44

S. G. FRANTZ CO., Inc.
Brunswick Pike and Kline Ave.
P. O. Box 1138 Trenton 6, N. J.

Condenser section of a 7½ hp unit. Note easy access to all components.





Productivity gets a lift from crane cabs that stay cool

Operator efficiency goes down when cab temperatures go up. That is why crane engineers demand crane cab conditioners that are dependable.

Dravo Crane Cab Conditioners *are* dependable because:

BASIC DESIGN—rugged construction and heavy duty components fit Dravo Conditioners for continuous service under the most severe operating conditions.

HIGH EFFICIENCY—low operating temperatures in condenser section, together with reduction of compressor head pressure step up unit efficiency.

EASY MAINTENANCE—all components readily accessible. Inspection need not interfere with conditioner operation.

For information on Dravo Crane Cab Conditioners, write for Bulletin #1350-33, Dravo Corporation, Pittsburgh 22, Pennsylvania.

DRAVO CORPORATION

VICTOR R. BROWNING

Mill Type Cranes TO SPECIFICATION...

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.
WILLOUGHBY (CLEVELAND), OHIO
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

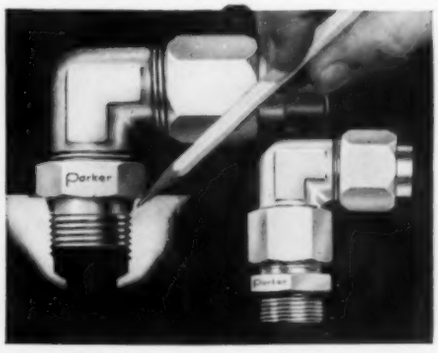
Be sure to see Parker for both tube and hose fittings!

Here, from one convenient source, you can get the most advanced hydraulic fittings available . . . both tube *and* hose. For example, new Parker *no-skive* Hoze-lok fittings require no stripping of rubber-covered hydraulic hose. They're faster, easier to use and *re-usable.*

Also, new Parker *straight-thread* tube fittings solve high-pressure hydraulic leakage problems resulting from tapered pipe threads. *Straight* threads are available on Triple-lok (the industrial standard flare tube fitting) and on Ferulok (flareless fitting for heavy steel tubing).

Parker
Hydraulic and fluid system components

No-skive Hoze-lok fittings need no stripping of hose covers. Only two simple steps complete the make-up. Re-usable.



Straight-thread tube fittings provide leakproof, trouble-free connections. No overtightening. O-ring makes the seal.

TUBE & HOSE FITTINGS DIVISION
Section 422-L
The Parker Appliance Co.
17325 Euclid Ave., Cleveland 12, Ohio

- ☐ Please send *no-skive Hoze-lok* Catalog No. 4433
- ☐ *Triple-lok* Catalog No. 4310
- ☐ *Ferulok* Catalog No. 4320

NAME_____

COMPANY_____

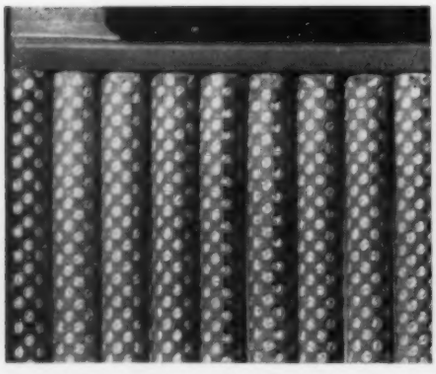
ADDRESS_____

CITY_____ STATE_____

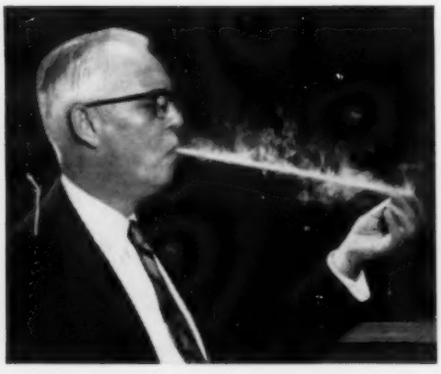
Get more work from your

NEW TG EXIDE-

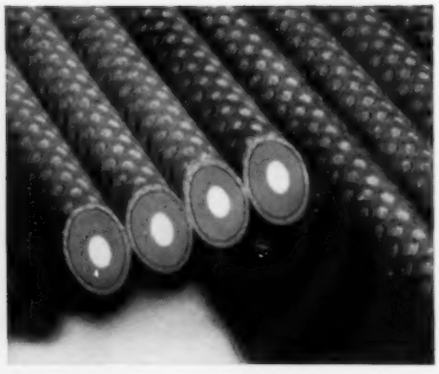
NEW POSITIVE AND NEGATIVE PLATES – DEVELOPED



New tubular construction of positive plate! Armored porous tubing. Provides resistance to corrosion and effects of vibration, improved flexibility, and maximum retention of active material. Thousands of tiny openings mean...



Greater porosity. Highly permeable tubes ease current flow, reduce internal resistance, improve access of electrolyte. Battery will deliver more power to meet sudden heavy loads. Tubes hold ...



More active material. Chief source of battery power. Larger inside diameter of tubes means every positive plate contains more active material per cubic inch of plate. And for maximum capacity and long life, there's a ...

electric industrial trucks

IRONCLAD BATTERY

Want more work hours—no increase in battery size? You get 44% more capacity in the new TG Exide-Ironclad Battery. For example, you can replace a 500 ah battery with a 720—in the same size. This means your trucks can do more work. They can earn a great deal more on your investment in them.

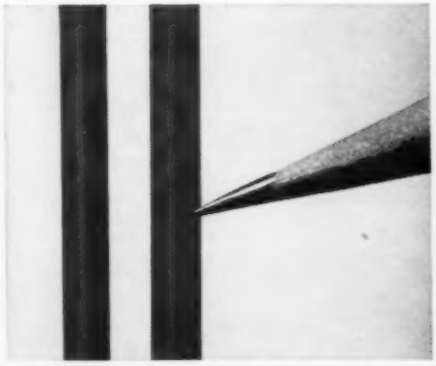
Satisfied with the work capacity of your present battery? Then get it at the lowest cost to own and operate—and get the newest, most advanced electric industrial truck on the market today.

Packs 44% more power into same battery space . . . priced to give you even greater battery economy

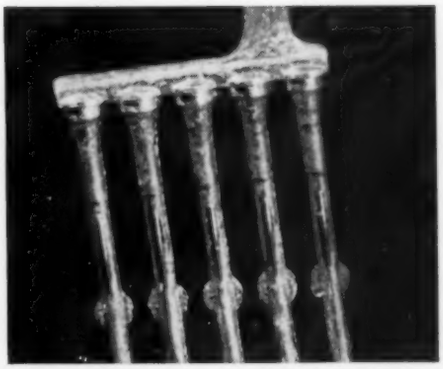
Want even lower operating cost and improved performance from your electric industrial trucks? Here Exide makes it possible. The new TG Exide-Ironclad Battery combines challenging new materials with an ingenious overall new design to produce the highest capacity per cubic inch of any battery available today. It's the most dramatic increase in capacity and the biggest step forward in power per dollar in history. This new battery can benefit every user of electric industrial trucks.

Learn more about the operating and expense advantages. Call your nearby regional Exide representative. Or write for complete information. Exide Industrial Division, The Electric Storage Battery Company, Philadelphia 1, Pa.

OUT OF RESEARCH STARTED 15 YEARS AGO



Thicker negative plate. Specially designed to match the increased capacity of the new positive plates. Plate is both thicker and stronger and possesses better electrical characteristics. You get all these advantages . . .



Plus Silvium,* Exide's exclusive grid alloy—proved more corrosion resistant than other leading grid alloys. Silvium is a patented combination of metals designed to prolong battery life. **U. S. patent*

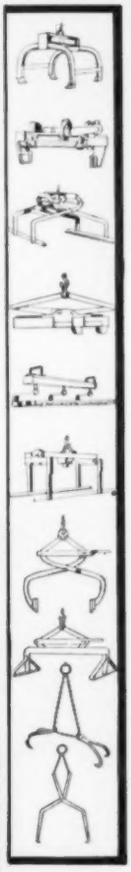
Exide®

The Electric Storage Battery Company

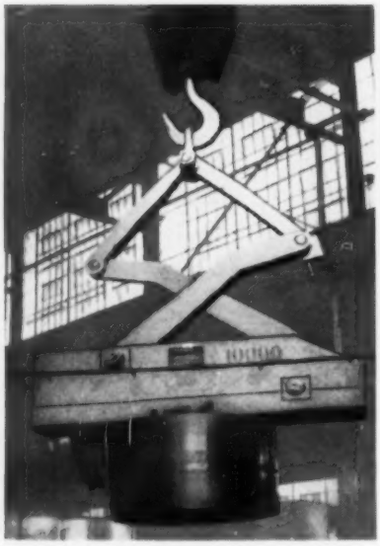
MANSAVER® GRABS

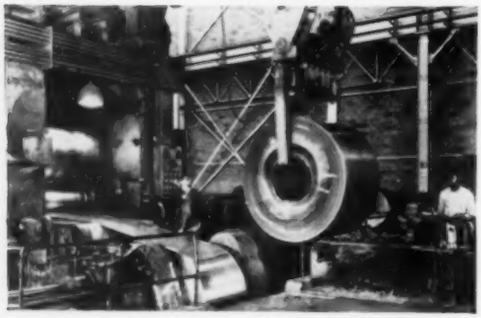
. . . Built by Experienced Engineers TO FIT YOUR NEEDS

Grabs look simple enough for any one to build, but those who really know depend on Mansaver's over thirty years' experience in designing and building better grabs. It is important for *you* to do business with a manufacturer with a long background of experience, and with sound financial standing.



Style 1616 Vertical COIL GRAB





Style 1418 Horizontal COIL GRAB

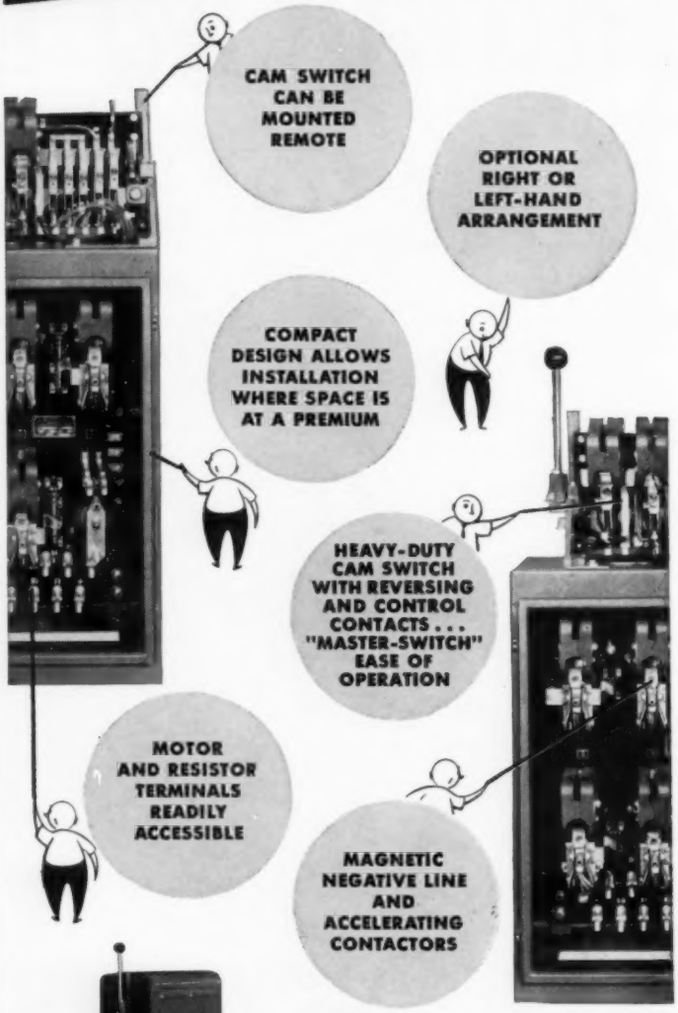
Style 1142 SHEET GRAB

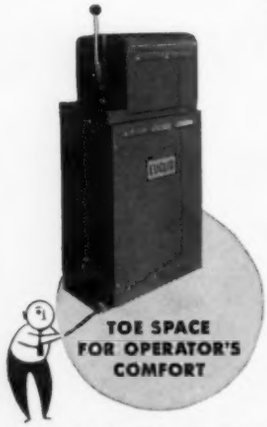
MANSAVER INDUSTRIES, INC., 3116 East St., New Haven, Conn.

NEW

HEAVY-DUTY D-C MAN-NETIC CONTROLLERS*

COMBINATION MANUAL and MAGNETIC CONTROLLER FOR CRANES—CHARGING MACHINES—D-C CONTROL JOBS


CAM SWITCH CAN BE MOUNTED REMOTE
OPTIONAL RIGHT OR LEFT-HAND ARRANGEMENT
COMPACT DESIGN ALLOWS INSTALLATION WHERE SPACE IS AT A PREMIUM
HEAVY-DUTY CAM SWITCH WITH REVERSING AND CONTROL CONTACTS . . . "MASTER-SWITCH" EASE OF OPERATION
MOTOR AND RESISTOR TERMINALS READILY ACCESSIBLE
MAGNETIC NEGATIVE LINE AND ACCELERATING CONTACTORS



2 TYPES AVAILABLE: REVERSE-PLUGGING OR DYNAMIC - LOWERING

Provide four speed points, reversing, with all advantages of full-magnetic control. Manually-operated cam contacts are free of destructive arcing . . . extremely fast magnetic contactor action interrupts power circuit before cam-operated contacts are opened. EUCLID'S EXCLUSIVE "TIMELOK" feature offers maximum dependable acceleration timing without extra relays . . . permits unusually compact arrangement of the magnetic panel.

For more information, contact our representative in your area, or write or call THE EUCLID ELECTRIC & MFG. CO., MADISON, OHIO.
Ask for Bulletin 4400-4401.

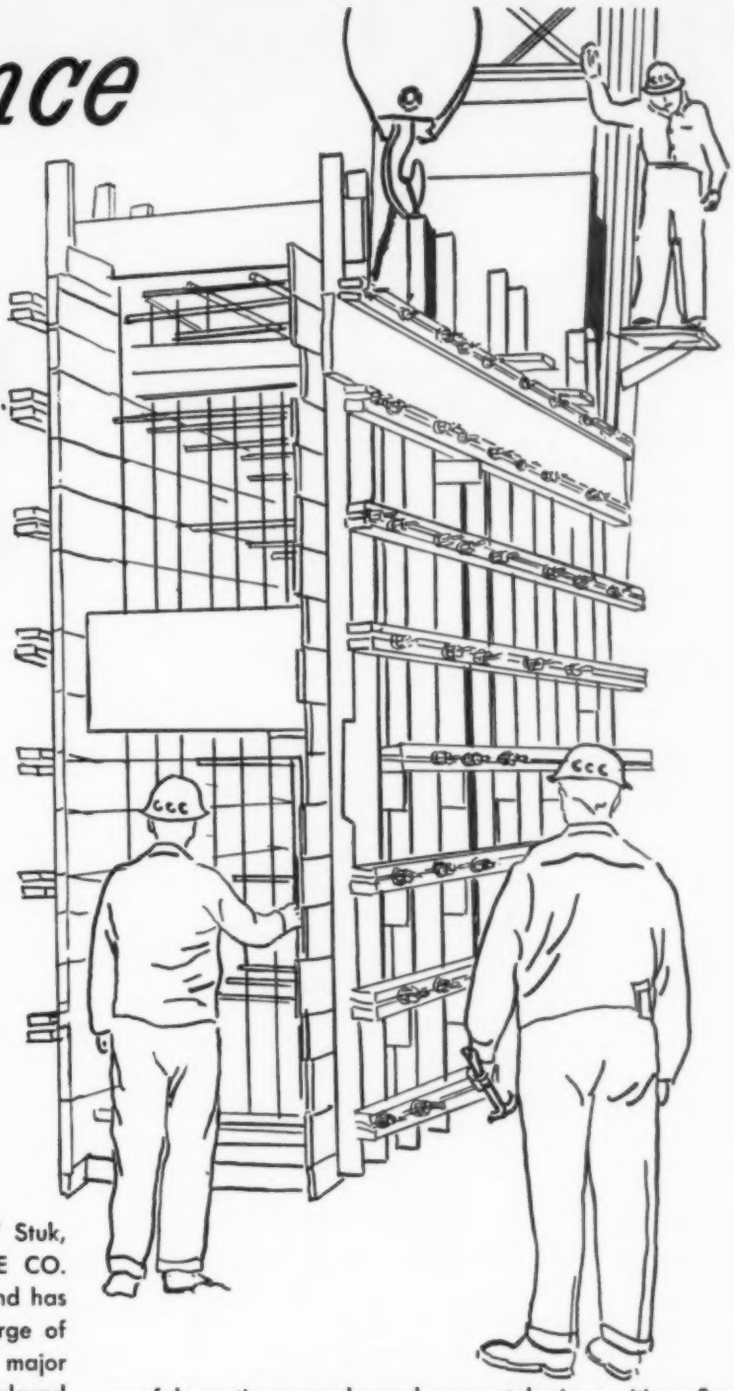
*PATENT APPLIED FOR.

THE EUCLID ELECTRIC & MFG. CO.
MADISON, OHIO

THE EUCLID ELECTRIC
EUCLID
AND MFG. CO., MADISON, OHIO

the difference between Champion & Runner-Up

JOSEPH STUK
GENERAL CARPENTER SUP'T.



Take for an instance the case of Joseph "Joe" Stuk, general carpenter supt. for CHICAGO CONCRETE CO. Joe, who has carried a carpenter's card since '28 and has been in a supervisory capacity 18 years, is in charge of prefabricated form work and scaffolding on all major projects wherein particular emphasis has to be placed on exactness and an understanding of what is called for and how best to accomplish that end.

His pet assignment is, working exclusively from prints, to supervise the building of forms and scaffolds by sections away from the construction site while other CHICAGO CONCRETE crews are at work preparing for new construction. Within minutes after the other crews are finished, Joe and his crew are fitting their pre-fab sections snugly and accurately in position. Savings in time affected through the efforts of Joe Stuk and his pre-fab crew literally run into days — even weeks!

While Joe Stuk is to be commended for his ability and technical ingenuity, it is to be noted that he is typical of the many skilled construction-men who make up the roster at CHICAGO CONCRETE . . . men anxious to tackle the next job that you have that calls for experience, know-how and the desire to get the job done right!

CHICAGO CONCRETE CONSTRUCTION CO.

DIVISION OF CHICAGO CONCRETE BREAKING CO.

12233 S. AVENUE "O" • CHICAGO 33, ILL. • BAyport 1-8400

PITTSBURGH AREA: 213 Corey Ave. • Braddock, Pa. • ELectric 1-1656

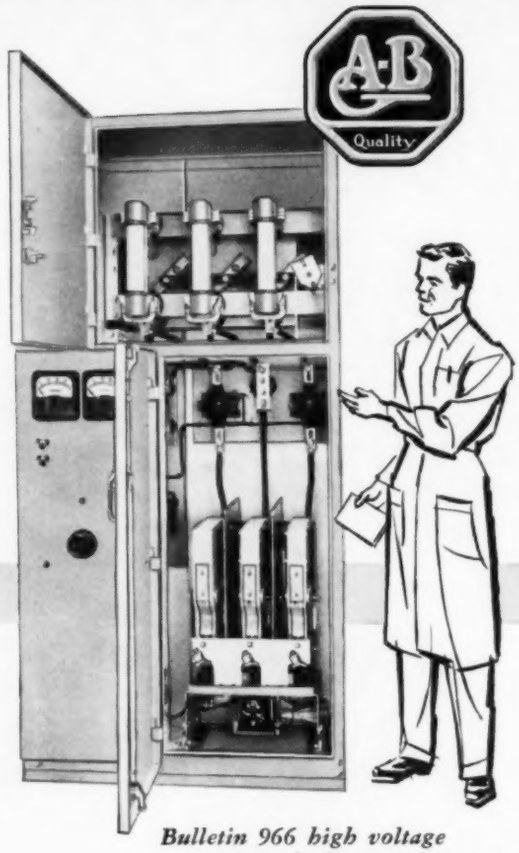
NEW...

HIGH VOLTAGE

AIR BREAK

MOTOR STARTERS

(Max 5000 volts)



Bulletin 966 high voltage across-the-line synchronous starter with new, long life, air break contactor.

Allen-Bradley has developed a new high voltage contactor—incorporating the same design features which have made the corresponding low voltage control so universally popular. The features listed below are your assurance of completely satisfactory starter operation—no matter what the service may be!

1—Only one moving part. Simple solenoid design eliminates all pins, pivots, and "flexible" jumpers.

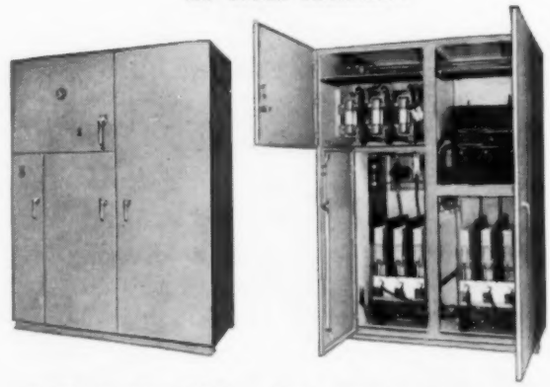
2—Double break, silver alloy contacts. Always in perfect operating condition.

3—Straight up and down solenoid motion assures good uniform contact pressures.

4—Compact. Unique design and development of new materials made possible a switch of unusually small size.

5—Easy access from the front. Easy to inspect and maintain.

6—Faster arc suppression. Double break contacts, plus new blowout design, plus novel arc chutes assure rapid arc extinction.



Bulletin 1172 high voltage, reactor type starters for squirrel cage motors, with the new air break contactor for heavy industrial service.

Using this new contactor as a base, Allen-Bradley has available a complete line of starters for all types of high voltage motors. For standard squirrel cage and synchronous motors, full voltage and reduced voltage, either nonreversing or reversing starters are listed. These high voltage starters can also be furnished for use with part winding or slip ring motors.

All Allen-Bradley high voltage starters are equipped with current limiting fuses and a front operated disconnect switch which is interlocked with not only the doors of the enclosure but also the high voltage contactor. Overload relays with current transformers provide continuously reliable motor overload protection.

For complete information about this new line of Allen-Bradley high tension starters, write for new engineering pamphlet.

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

Allen-Bradley Co.
1343 S. First St., Milwaukee 4, Wis.

In Canada—
Allen-Bradley Canada Ltd., Galt, Ontario

Publication Service...

APRIL, 1957

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Heaters and Heating Devices

A catalog giving information on such new products as redesigned cartridge heaters, miniature soldering irons, aluminized steel sheath strip heaters, and new ratings and configurations of finned tubular heaters has recently been published by General Electric Co. A 16-page power requirements section, showing short and long form calculations for heating applications, is also included. In this section, each heating process is described. Typical application problems are solved to give heating requirements in both a long and a short form method. The catalog includes data, specifications, operating information and manufacturer's recommended list prices of standard General Electric heaters and heating devices. Included are immersion, strip, cartridge, tubular, finned tubular and railroad switch heaters; unit heaters, soldering irons, soft metal melting pots, oven equipment and control. (Bulletin GEC-1005H)

(2) Spectrochemical Analysis

A comprehensive booklet that outlines the instruments and accessories encountered in all phases of spectrochemical analysis is being distributed by the Jarrell-Ash Co. This brochure represents the first of a series of spectrochemical reference handbooks being prepared by Hilger & Watts Ltd., noted British instrument manufacturer. The book describes the basic fundamentals of spectrochemical analysis, and also includes a bibliography of reference material. (CH401)

(3) Shut-off Valve

A new bulletin entitled "Freyn-Jansen Burner Shut-off Valve," has been issued by the Freyn Department, Engineering & Construction Div. of Koppers Co., Inc. Complete with scale drawings, sizes, and specifications, the new booklet emphasizes how the valve reduces stove-changing time, prevents gas leakage, provides tight, sure closure and reduces maintenance. (Booklet E-39)

(4) Speed Reducers

The Falk Corp., has published a booklet on their concentric shaft and right angle speed reducers for applications up to 140 hp (up to 72,000 lb-in. output torque). Horsepower and torque ratings are given, as well as dimensions, overhung load and thrust capacities and application pictures. Horsepower selection tables have been revised to show at a glance (1) the standard output speeds that may be obtained with commonly used input speeds, and (2) the full range of hp ratings available for each standard output speed. (Bulletin 1105)

(5) Fans

Robinson Ventilating Co., has published a new bulletin on their heavy duty industrial fans. Illustrations of their custom built fans ready for service are included, as well as photos of fans operating in different types of plants. The bulletin also contains an index to their various types of equipment. (Bulletin #502)

(6) Float Valves

A technical bulletin explaining the features of their cushioned float valves has been published by Golden-Anderson Valve Specialty Co. Parts lists, dimensions, approximate shipping weights for the various sizes, operation, installation, and other pertinent information on each of the various types of float valves is contained in this new catalog. (Bulletin W-5)

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 1964, Sec. 34.9, P. L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER

1010 EMPIRE BUILDING

PITTSBURGH 22, PA.

IRON & STEEL ENGINEER

Send The free Booklets Circled Below:

*APRIL, 1957

1	2	3	4	5	6	50	51	52	53	54
55	56	57	58	59	60	61	62	63	64	65
66	67	68	69	70	71	72	73	74	75	76
77	78	79	80	81	82	83	84	85	86	87
88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105	106			

NAME _____ TITLE _____

DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

* INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER AUGUST 1, 1957

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	AIR REDUCTION SALES CO.	CATALOG 1318	Electrodes
51	ALLEN-BRADLEY CO.		High tension starters
52	ALLIS-CHALMERS MFG. CO.	BULLETIN 14R8615	Controls
53	ALLIS CO., LOUIS	BULLETIN 105	Electric motors
54	ASKANIA REGULATOR CO.	BULLETIN 33.2	Arc furnace control
55	BAILEY METER CO.		Permanent analyzer-recorder
56	BRISTOL CO.	BULLETIN A130	Pneumatic controllers
57	BROOKS OIL CO., THE	ENG. LETTER 73IS & ENG. LETTER 86IS	Leadolene and Klingfast oils
58	BUFFALO FORGE CO.	BULLETIN 2424-F	Rubber-lined exhausters
59	BUSSMANN MFG. CO.	BULLETINS FIS & HCS	Dual-element fuses and hi-cap fuses
60	CHEMICAL CONSTRUCTION CORP.		Washers
61	CLEVELAND WORM AND GEAR CO.	BULLETIN 145	Drives
62	CLEVELAND WORM AND GEAR CO.	CATALOG 400	Worm gear speed reducers
63	CUNNINGHAM CO., M. E.	DATA SHEET 653	Billet mill cut letter stamps
64	CUTLER-HAMMER, INC.		Line welded, bolted and special magnets
65	DE LAVAL STEAM TURBINE CO.	BULLETIN 1004	Centrifugal pumps
66	DIAMOND POWER SPECIALTY CORP.		Industrial wired television
67	DURALOY CO., THE		High alloy castings
68	ELECTRIC CONTROLLER AND MFG. CO., DIVISION SQUARE D CO.	BULLETIN 6550	Automatic positioning screwdown controls
69	ELECTRIC SERVICE WORKS, DELTA-STAR ELECTRIC DIV., H. K. PORTER CO., INC.		"Lec-trol-feed" conductor systems
70	EUCLID ELECTRIC & MFG. CO., THE	BULLETIN 4400-4401	Controllers
71	FRANTZ CO., INC., S. G.	PM-44	Magnetic separators
72	GARLOCK PACKING CO., THE		"Klozure" oil seals
73	GEAR GRINDING MACHINE CO., THE		Constant velocity universal joints
74	GULF OIL CORP.		Gulfcrown oil
75	HARNISCHFEGER CORP.		Electronic crane control
76	HERR EQUIPMENT CORP., THE	BULLETIN NO. 561	Processing and handling equipment
77	HOLOPHANE CO., INC.		Industrial lighting
78	IRON LUNG VENTILATOR CO.		Ventilating problems
79	I-T-E CIRCUIT BREAKER CO.	BULLETIN 6004B	Circuit protection
80	JOY MANUFACTURING CO.	BULLETIN B41	Electrical connectors
81	LARCO, INC.	BULLETIN AC-573	Crane cab and pulpit air conditioners
82	LINK-BELT CO.	BOOK 2324-A	Worm gear drives
83	LOEWY-HYDROPRESS DIVISION, BALDWIN-LIMA-HAMILTON	BULLETIN L-164	Designers and builders of rolling mills
84	MCGREGOR-MICHIGAN CORP.		Steel plate fabricating
85	MICHIGAN TOOL CO., CONE-DRIVE GEARS	BULLETIN CD-400	Gears
86	OHIO ELECTRIC MFG. CO., THE	BULLETIN 112	Magnets and magnet controllers
87	OKONITE CO., THE	BULLETIN IS-1106	Insulation
88	PANGBORN CORP.	BULLETIN 606	Descaling machines
89	PARKER APPLIANCE CO., THE	CATALOGS 4433, 4310, 4320	Tube and hose fittings
90	POST-GLOVER ELECTRIC CO., THE	BULLETIN NO. 500	Steel grid resistors
91	RADIO CORPORATION OF AMERICA		Industrial television
92	REFRACTORY AND INSULATION CORP.		Refractory bonding mortars
93	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN D-2501	Machine tool feed drive
94	ROCKBESTOS PRODUCTS CORP.		Asbestos, varnished-cambric insulated cable
95	RUST FURNACE CO.		Furnaces
96	RUST-OLEUM CORP.		Rust preventive literature
97	SIMMONS MACHINE TOOL CORP.		Descriptions of modernized and rebuilt machine tools
98	STAMCO, INC.		Slitting and coiling equipment
99	STEARNS MAGNETIC PRODUCTS	BULLETIN 35-CI	Lifting magnets
100	SUTTON ENGINEERING CO.	BULLETIN NO. 25	Straighteners
101	SYNTRON CO.		Bin vibrators, battery charges, electric hammers, etc.
102	TAPECOAT CO., THE		Coal tar coating
103	UNITED STATES GRAPHITE CO., THE		Brushes
104	UNITED STATES STEEL CORP. INDUSTRIAL CARS		Custom designed cars
105	WAGNER ELECTRIC CORP.	BULLETINS MU-202 & MU-203	Motors
106	YODER CO., THE		Cold roll forming

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

IRON & STEEL ENGINEER

Send The free Booklets Circled Below:

*APRIL, 1957

1	2	3	4	5	6	50	51	52	53	54
55	56	57	58	59	60	61	62	63	64	65
66	67	68	69	70	71	72	73	74	75	76
77	78	79	80	81	82	83	84	85	86	87
88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105	106			

BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 34.9, P. L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER

1010 EMPIRE BUILDING

PITTSBURGH 22, PA.

NAME _____ TITLE _____

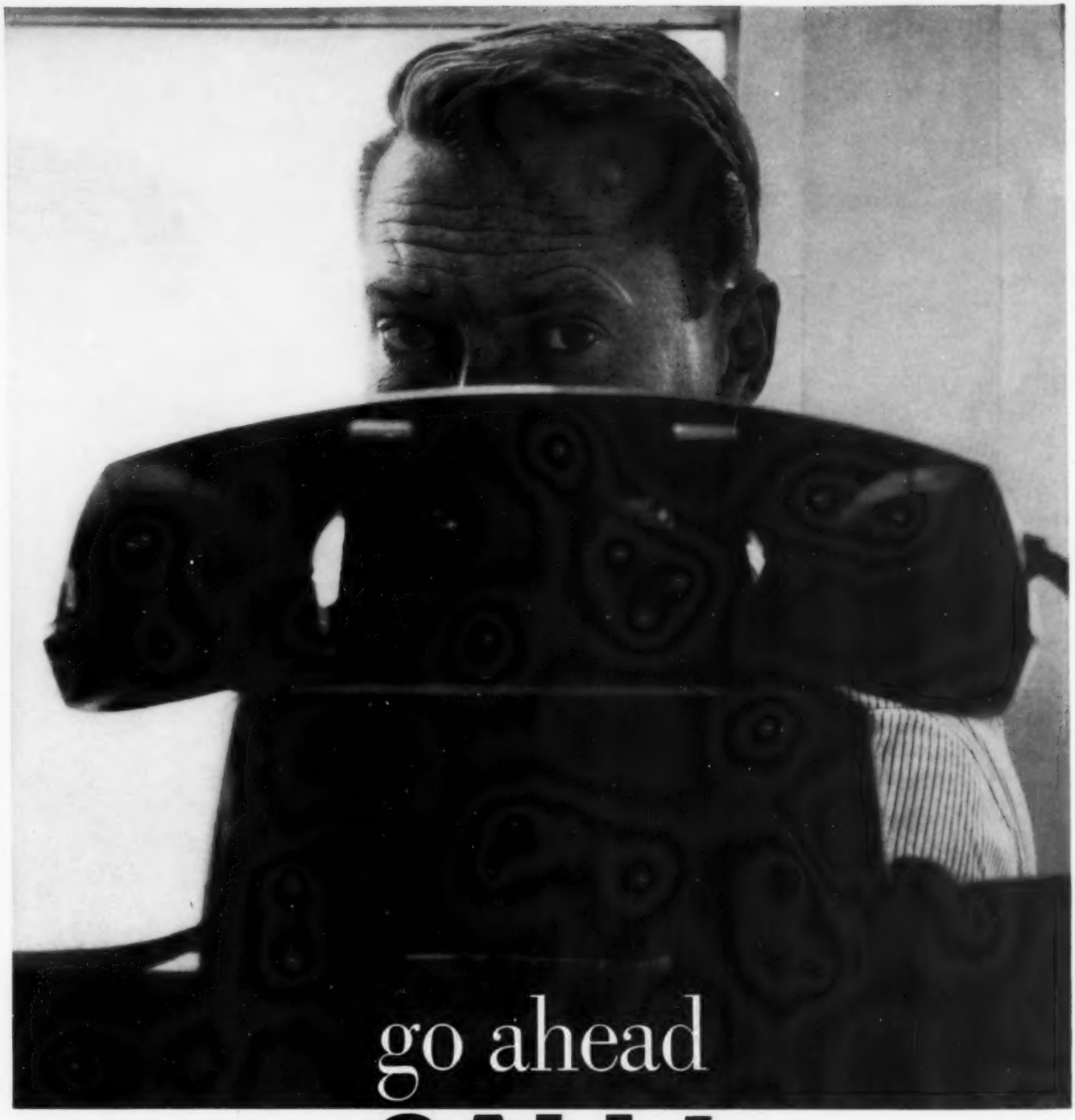
DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

* INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER AUGUST 1, 1957



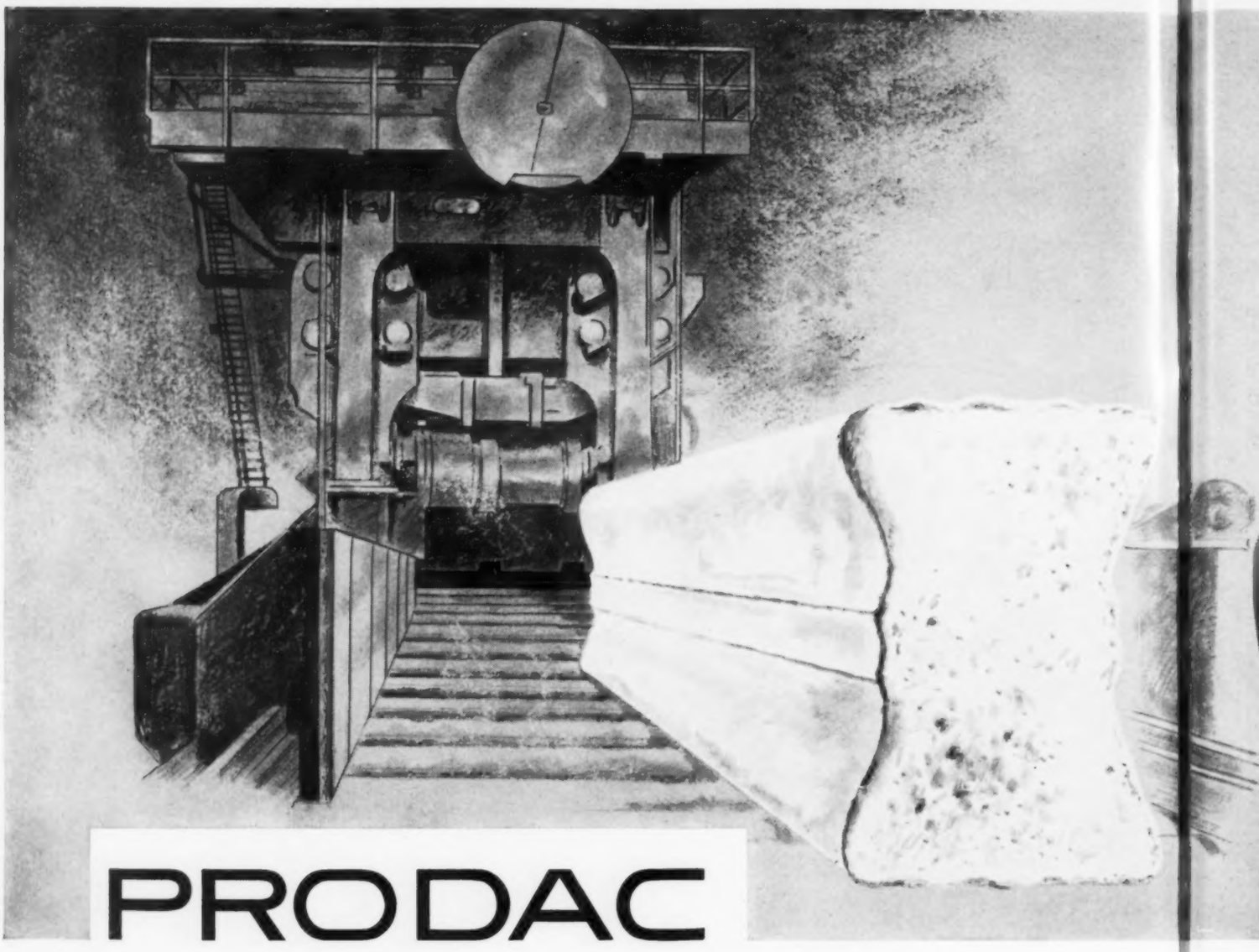
CALL!

the fastest cure for worry about cancer: a call to your doctor now!

Scared? You shouldn't be! Look at it this way. The average man who walks into the doctor's office walks out floating. That lump that was so frightening . . . nothing to worry about at all! The sky's bluer, the air's sweeter, it's a great big beautiful day . . . because he picked up that phone and called!

It happens all the time. It can happen to *you*. "Sure," you say, "but just supposing"... OK. Let's look at the facts. In past years, we were saving 1 out of 4 cancer patients. Today, we're saving 1 in 3. And the odds could get better still . . . if *people would call their doctors in time!*

So go ahead...call. See your doctor now. And after your checkup—how about a check for the American Cancer Society? Every dollar sends us further along the road to cure. And when *that* happens . . . it's going to be a wonderful day for us all! Send your check to "Cancer" in care of your local Post Office.



PRODAC

PROGRAMMED DIGITAL AUTOMATIC CONTROL

a revolutionary new steel mill control by Westinghouse

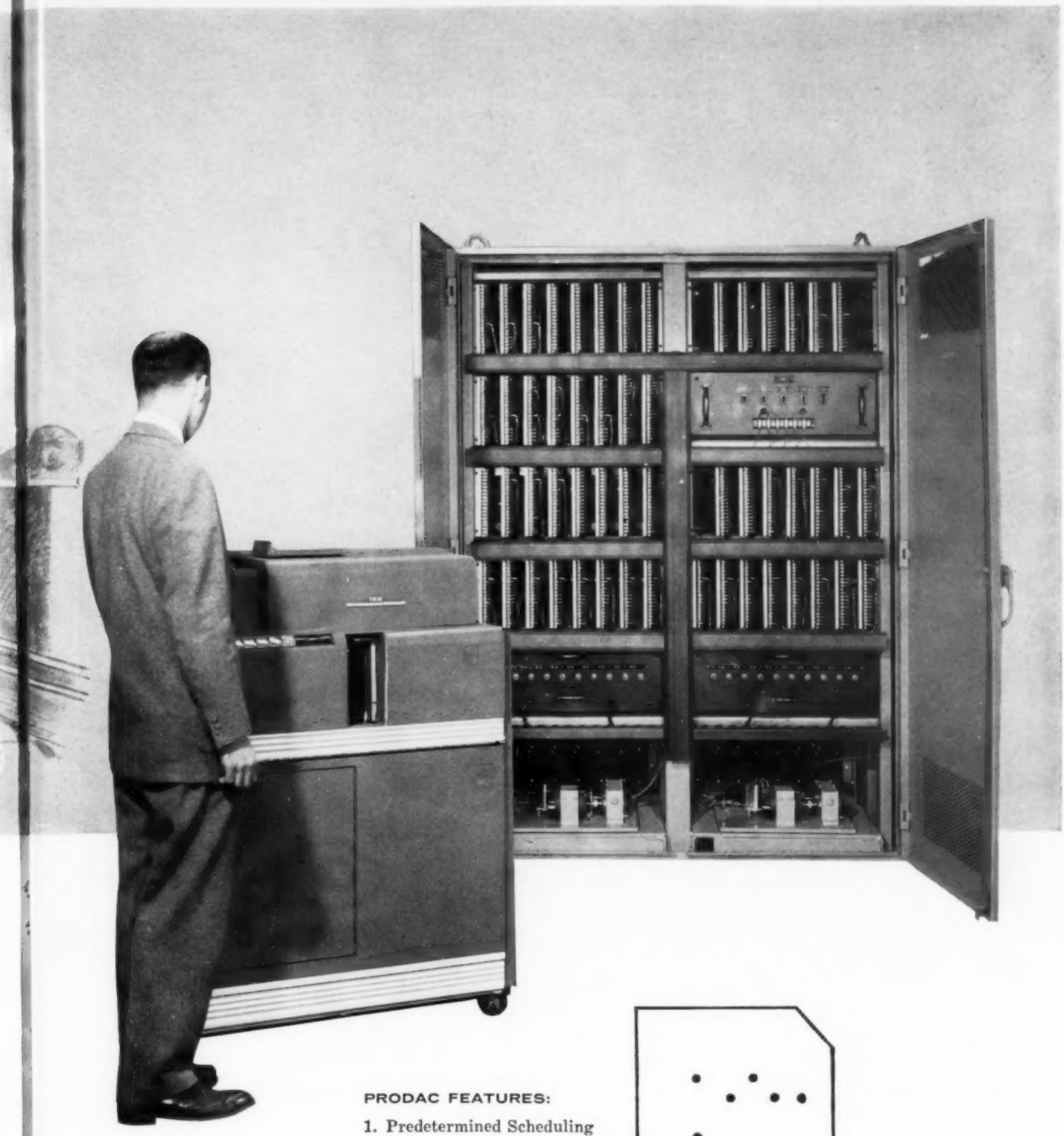
With Westinghouse PRODAC*, the full capacity of mill equipment can be utilized. This revolutionary new mill control now makes possible a consistent capacity production rate with positive accuracy in operation.

Through the card programmed system, mill operation is completely predetermined. To initiate a rolling schedule, the operator just feeds in the pre-punched "reader" cards. He then pushes a button, and the control automatically runs the mill, makes the necessary number of passes, and provides continuing adjustment of mill speed and screwdown opening.

To find out how Westinghouse Systems Control Engineering can apply PRODAC to your mill operation, call your Westinghouse representative. Or, write Westinghouse Electric Corporation, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

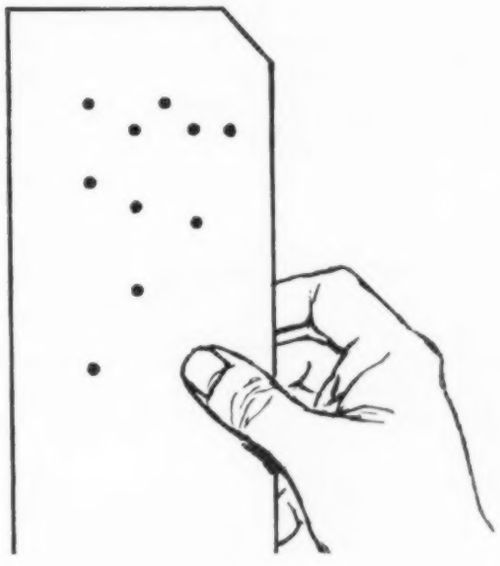
J-22006
*Trademark

YOU CAN BE SURE...IF IT'S Westinghouse



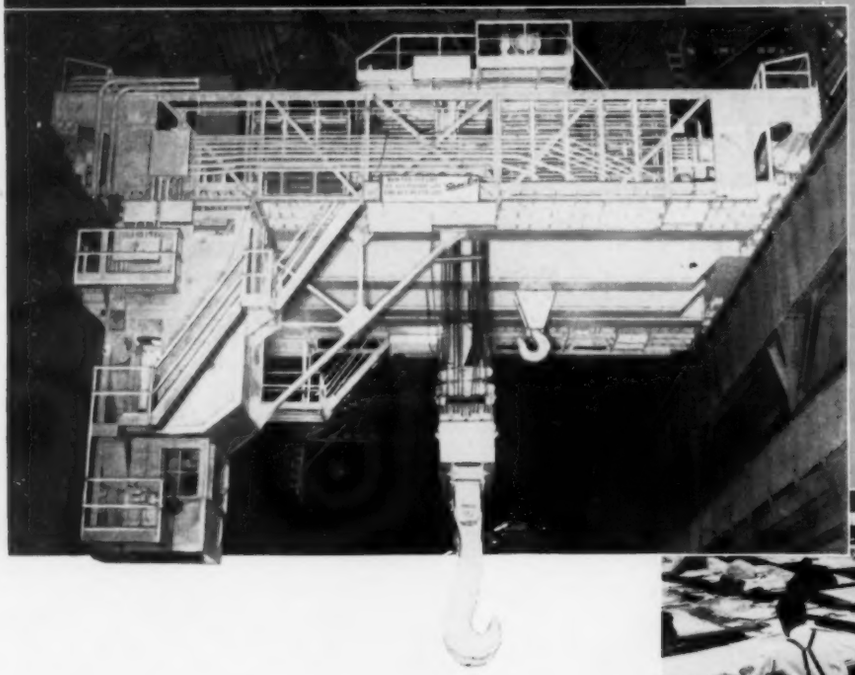
PRODAC FEATURES:

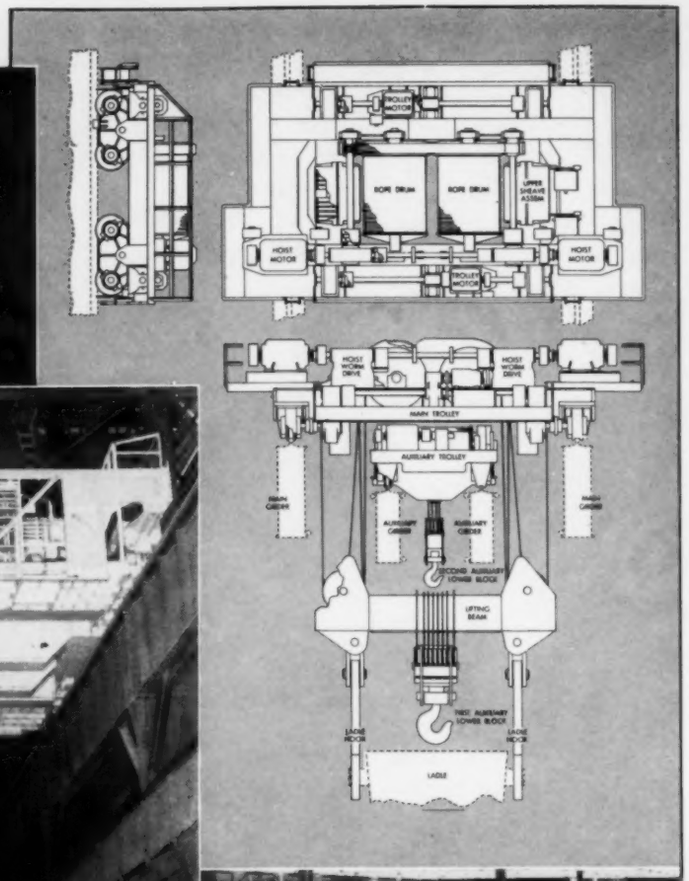
1. Predetermined Scheduling
2. Digital Representation and Treatment of Data
3. Punched Cards
4. Transistor Circuitry
5. MAGAMP* Regulators
6. Ultimate Control of Adjustable-Voltage Drives



"SHAW-BOX" CRANES

built to AISE Specs or your own





Complete dependability. Economical operation. Convenient maintenance. "Shaw-Box" Cranes are demonstrating these essentials effectively in steel mills all over the country every day. Whether built to mill or AISE Standard No. 6 Specification, "Shaw-Box" Cranes give years of reliable performance in the toughest services.

The giant "Shaw-Box" Ladle Crane pictured here raises a 90-ton ladle containing 200 tons of molten steel. A 75 ton auxiliary trolley, also a part of the unit, operates independently for handling of lighter loads. It is a 4-girder, 9-motor crane with a 54-foot span. Creative engineering contributes *exclusive* structural, mechanical and operational advantages that assure rugged strength and functional perfection.

Make certain of experienced interpretation of your requirements, whether your plans include a ladle crane, a soaking pit carriage or a crane to handle plate or slabs. Our vast crane-building facilities and special manufacturing techniques can be of real value to you. We have standard AISE designs for 15 to 100-ton cranes, so you pay less for engineering and get more for your purchase dollars. Invite one of our engineers to discuss specifications. No obligation, of course.

57K-4

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

"Shaw-Box"® CRANES

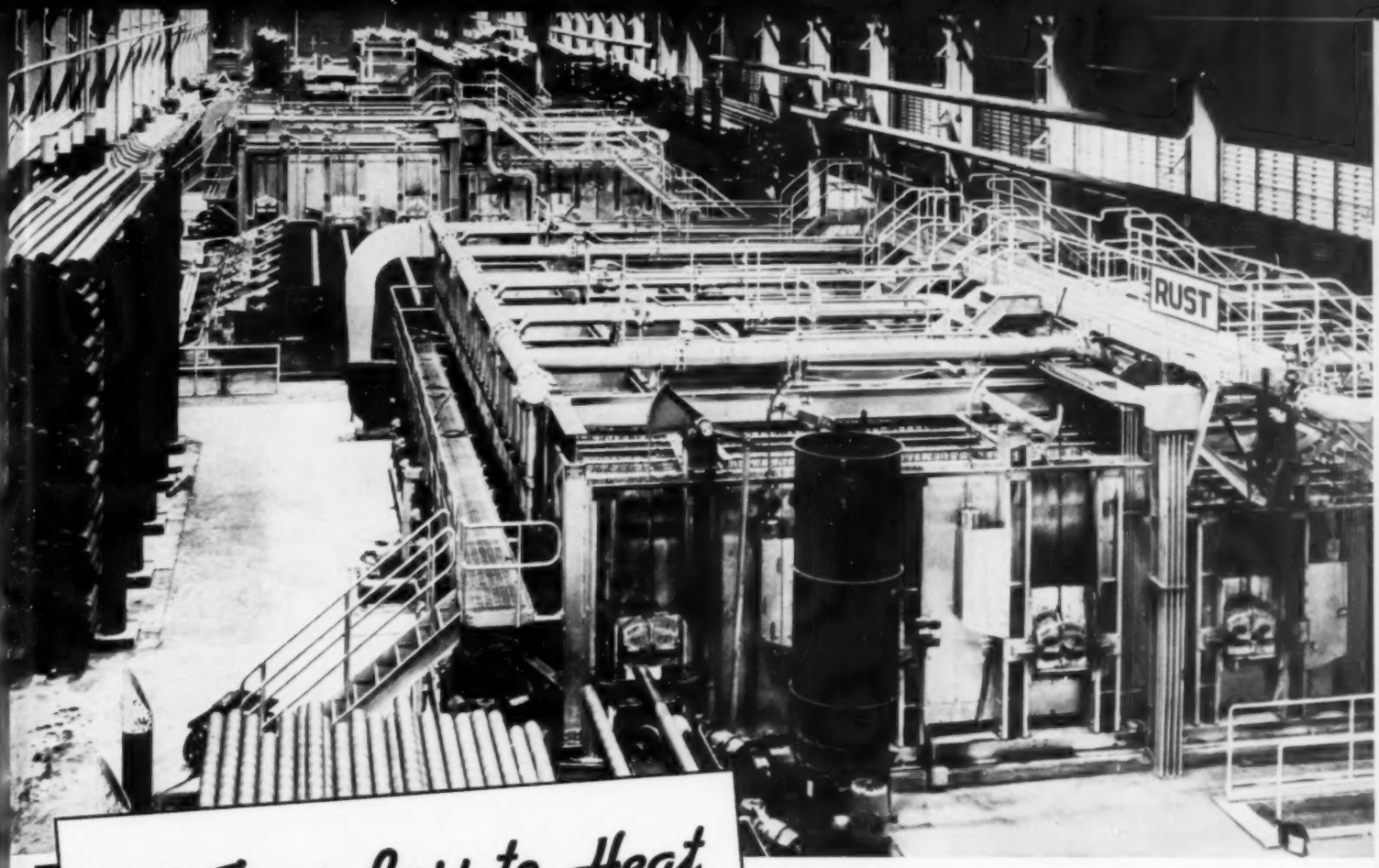
MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION

388 West Broadway • Muskegon, Michigan

Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Other Divisions produce 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments, and Aircraft Products.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Avenue Road, Galt, Ontario*



116 Tons Less to Heat in this roof

because of B&W Insulating Firebrick suspended construction

Here's another case where light weight means lower cost. The roof of this walking beam furnace is 2,320 square feet. B&W Insulating Firebrick suspended construction for a 9-inch roof weighs about 30 lbs per square foot, including the weight of rods, hangers, pipe, brick and mortar. This is approximately 100 lbs per square foot less than an arch constructed of heavy firebrick plus insulation having the same heat flow. *This saving means the B&W IFB roof is 116 tons lighter.*

The new walking beam furnace (shown in photograph above) was designed and constructed by Rust Furnace Company for Jones & Laughlin Steel Corporation. Seamless pipe is conveyed into the furnace, moves slowly from left to right on walking beam rails designed and furnished by York-Gillespie Mfg. Co., and passes out the exit door.

Here are the money-saving benefits of B&W suspended construction:

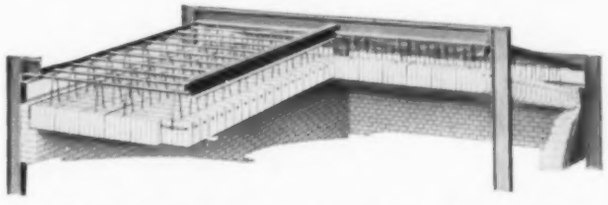
1. Supporting steel is less massive, far less costly. Commercial size steel can be used for roof suspension instead of special castings.

2. B&W Insulating Firebrick heat up and cool down faster. This means lower fuel costs, faster inspection.

3. Furnace temperatures can be changed quickly. When different steels call for different heating schedules, the furnace temperature can be adjusted in minutes instead of hours.

4. Installation costs are lower because these lightweight brick can be handled faster and easier than ordinary heavy firebrick.

For complete information on B&W IFB—the *lightest* weight insulating firebrick, write to B&W today or call your local Refractories Engineer.



This is a cross-sectional drawing of a typical suspended arch arrangement using B&W Insulating Firebrick. It can be used in flat or sloping roofs, nose arches and many other types of suspended furnace construction.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42ND ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

R 535

TRABON

WITH ORIGINAL "METERFLO"

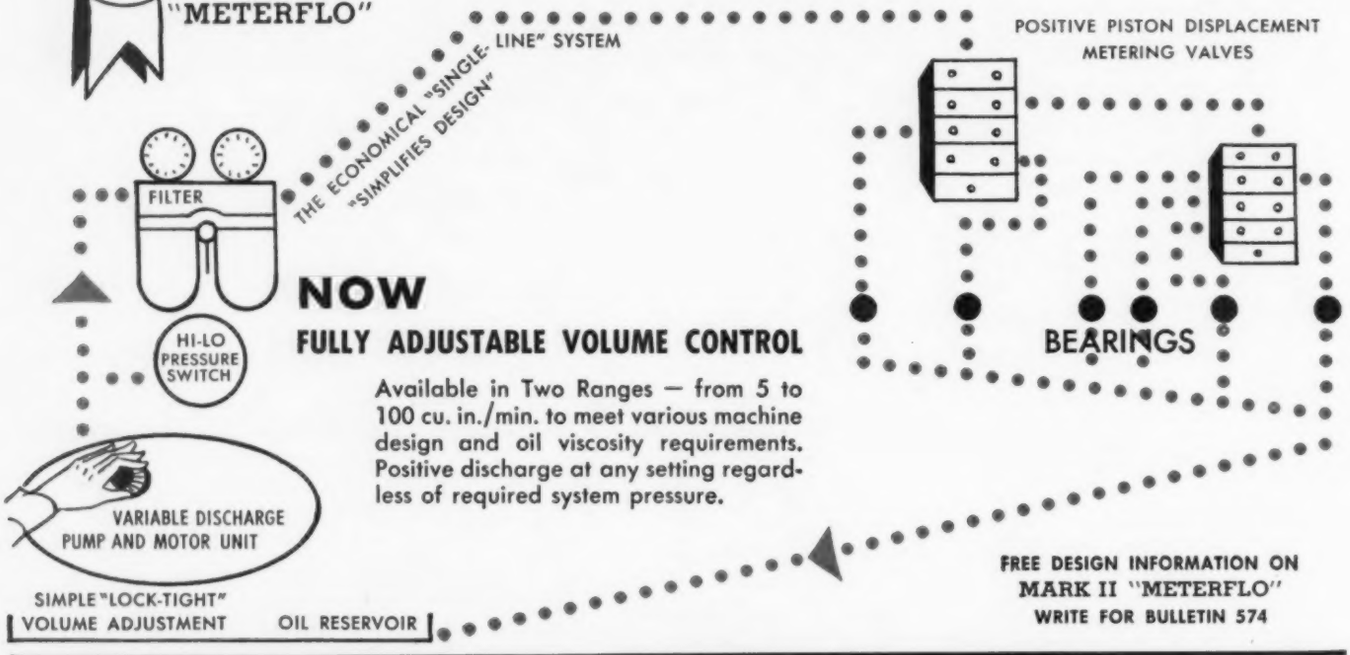
Announces...

MARK II

"METERFLO"

CIRCULATING OIL LUBRICATION SYSTEM

POSITIVE OIL FLOW TO EVERY BEARING UNDER PRESSURE



NOW

FULLY ADJUSTABLE VOLUME CONTROL

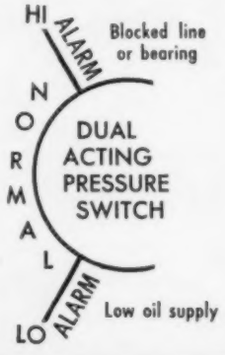
Available in Two Ranges — from 5 to 100 cu. in./min. to meet various machine design and oil viscosity requirements. Positive discharge at any setting regardless of required system pressure.

FREE DESIGN INFORMATION ON MARK II "METERFLO" WRITE FOR BULLETIN 574

PLUS CALIBRATED DUAL PRESSURE SWITCH EQUIPMENT

Compact dual-acting pressure switch now includes calibrated adjustment for simple and ready adaptation to meet all field conditions. "Pressure-dampened" switch and gauge equipment—for longest equipment life and elimination of any momentary "false" pressure signals.

Wide normal operating range assures positive metered quantity **regardless of length of line or varying bearing resistances.**



NOTE TO MACHINE DESIGNERS

- Hi-Pressure dual cartridge filter—a turn of the handle permits cartridge change without stopping system—"quad" ring seal construction for leak-proof operation.
- Wide range metering valve sizes for ultra-fine metering requirements (i.e. exposed sliding surfaces)—plus accurate control over output ratios of 20-1 and higher within the same system.
- Protection against failure of oil to reach bearings for **any** reason.
- Constant positive pressure feed regardless of change in temperature or oil viscosity.
- "Packaged" power units—complete sump, pump, and control units available in any desired combination.

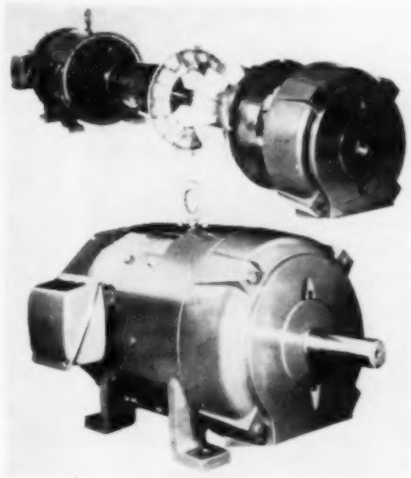
For further economy, non-adjustable units also available.

TRABON ENGINEERING CORPORATION
28815 AURORA ROAD SOLON, OHIO

Equipment News...

MOTOR-GENERATOR LINE

▲ A new line of d-c industrial motors and generators known as the Life-Line "H" series has been announced by the motor department of Westinghouse Electric Corp. Now in production, the line departs markedly from traditional designs to achieve a new measure of performance and dependability from standard d-c machines. They are designed to be equally effective as



basic prime movers or as elements of highly complex automatic production systems.

The new motors and generators have dripproof enclosures as standard and bear NEMA Class B ratings; they span motor ratings from 1 to 150 hp and generator ratings from $^3/_4$ to 100 kw.

Among features available for the first time in standard industrial motors and generators are a high-temperature silicone insulation system in machines rated to operate within Class B temperatures; a controlled ventilation system that draws air from the drive end, distributes flow positively throughout the machine, and expells it at the commutator end; and a new housing construction which enables the dripproof machines to serve many applications which ordinarily require splashproof equipment. Further, as the result of a marked decrease in armature inertia and improved commutating ability, the motors are capable of the fastest dynamic response now available with standard industrial machines. Armature inertia of the entire line has been decreased—by as much as 55 per cent in some ratings—and commutating ability increased by 35 per cent.

The machines feature silicone treatment throughout with multiple dips and bakes at 200 C to seal against dirt and moisture and assure thermal stability. This treatment is complemented by glass, mica and other high temperature materials to attain the proper balance of dielectric, thermal and mechanical properties. Accelerated life tests indicate motor insulation life will be at least 10 times that for ordinary Class B under any conditions. Also, the insulation is equal to many emergency overloads, abnormal ambients, or rigorous duty cycles; the risk of burnouts or extremely shortened life that would ordinarily occur is reduced greatly.

A fan at the shaft end is teamed with an air shield and a diffuser to impell air flow through the machine and out at the commutator end. Accordingly, commutator dust is expelled rather than deposited upon the windings; also, small particles in the incoming air stream are prevented from striking the commutator directly. Optimum cooling is made possible by the diffuser, which divides the air stream for most effective flow through the armature, air gap, and fields. Total flow is maximized since the fan action of the armature promotes flow rather than impedes it.

Armature inertia is reduced by as much as 55 per cent over previous standard motors. Up to half of this reduction is made possible by the improved armature cooling resulting from controlled ventilation.

SHIP GRAB BUCKETS FOR HANDLING HOT SLAG

This four-cubic-yard slag grab, shown before shipment from the Harrison, N. J. plant of the Mead-Morrison Division of McKiernan-Terry Corp., is one of three ordered for United States Steel Corp.'s Youngstown, Ohio, plant. The buckets were specifically designed and fabricated to fulfill the particular requirements of handling hot open-hearth slag. The buckets feature a special reeving arrangement, special steels, and the incorporation of a new link-type hinge alignment device that prevents grab damage due to jamming of the noncrushable slag in the gear teeth of conventional alignment devices.

35% NICKEL

DURALOY

15% CHROMIUM

Furnace Castings

Here are two good examples of our work in high-nickel castings!

These are in the Duraloy HT group calling for Ni 33.37 percent. We've gone as high as 68% nickel on some castings where extremely high temperatures and very severe corrosive conditions had to be resisted. The important factor concerning castings for exceptionally high temperatures is that they must retain their structural form under load.

Knowing just how much nickel to put in and how much chromium and other alloying elements depends to a large extent on experience . . . and it is experience that we can offer you for the castings you need. We've been producing static castings since 1922 and centrifugal castings since 1933, being among the pioneer founders in each class.

If you would care to have our metallurgist study your casting problem, we shall be glad to have you call upon us for the service.

Our New General Catalog is yours for the asking.

THE DURALOY COMPANY

OFFICE AND PLANT: Scottdale, Pa.

ATLANTA OFFICE: 76—4th Street, N.W.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.
CHICAGO OFFICE: 332 South Michigan Avenue

The balance of the reduction results from the longer frames and Class B ratings now standard throughout the industry.

For maximum dynamic response, reductions in inertia are accompanied by improved commutating ability. One-minute current is now rated at 200 per cent—rather than 150 per cent—as the result of a variety of refinements in brush rigging, commutator, armature and commutating fields.

The housing is designed for maximum protection and simplified installation and maintenance. All commutator access openings have gasketed covers. The single ventilation opening in each bracket faces downward and has a rectangular flange suitable for simple connections to ducting. Brackets can be rotated to locate the vents properly for floor, wall or ceiling mounting. Similarly, the conduit box can be rotated for top, bottom or side entrance and can be mounted on either side of the frame. The frame is heavy rolled steel with forged low-carbon steel feet; cast brackets are ribbed for strength.

ROLLING MILL

▲ A machine that rolls metal powders directly into strip material has been developed by Stanat Manufacturing Co., Inc. The unit is designed primarily as a tool for processing fuel elements used in nuclear reactors.

The technique of rolling metal powders into strip is said to compare favorably with both the wrought and die-compacting and sintering methods of metallurgical processing. For example, studies made by rolling 18-8 stainless steel powder revealed that it is possible to produce strips of high-density, good ductility, high tensile strength, good corrosion resistance and desirable crystallographic orientation.

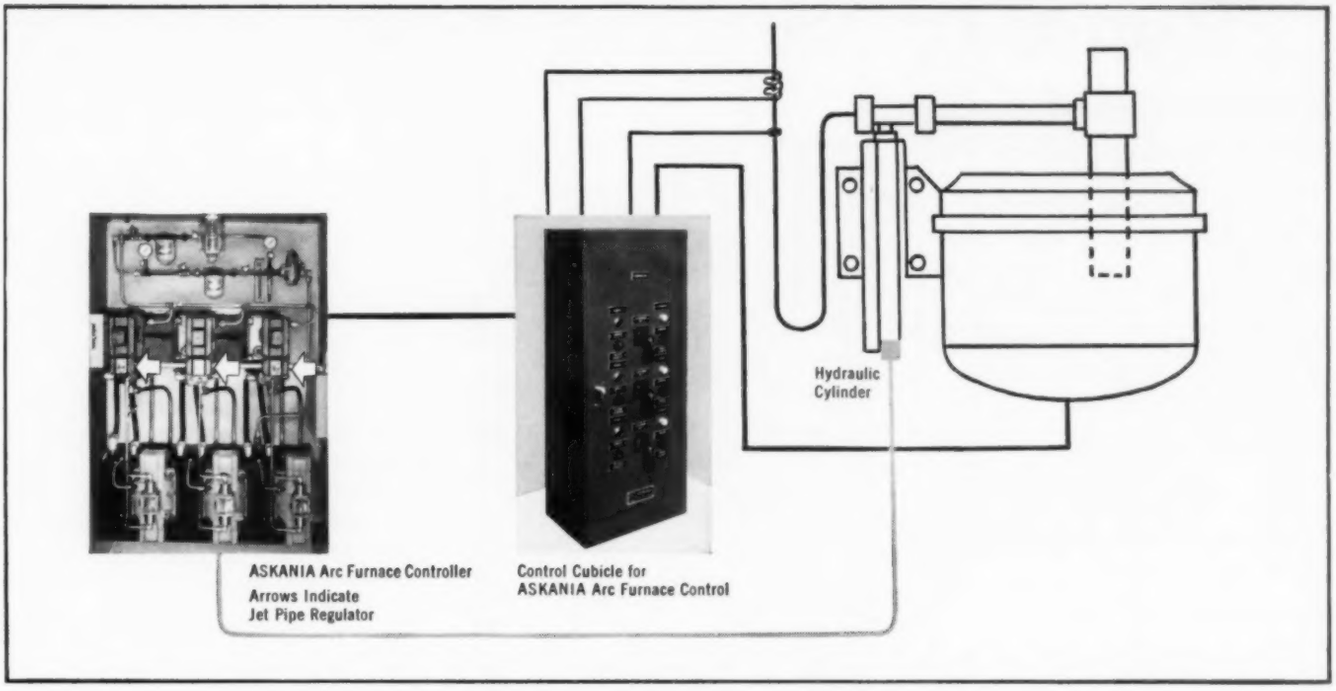
AIR COMPRESSOR

▲ A new heavy-duty industrial air compressor in the 350 to 1000 hp range has been announced by Joy Manufacturing Co.

The unit, labelled the WN-224, has an output at 80–125 PSIG, rated from 2418 to 6048 CFM, depending on motor horsepower. The new compressor is a four-

Askania Regulator Company NEWS

Automatic Controls for
COMBUSTION • PRESSURE • FLOW • STRIP EDGE POSITION • STRIP THICKNESS



ASKANIA Arc Furnace Control for Faster, More Accurate, More Dependable Control of Electrodes

With ASKANIA Arc Furnace Control voltage and current signal measurements are converted directly into electrode movement through the mill-proven ASKANIA Jet Pipe Relay...*to correct any imbalance with the speed and stability of proportional speed floating control.*

Electrically, the ASKANIA Arc Furnace Control balances arc current and voltage to maintain preset power input as determined by the operator.

CONTROL ADVANTAGES

1 • *FAST*—Takes full advantage of non-compressible hydraulic fluid to accelerate or decelerate heavy loads—through zero.

2 • *ACCURATE*—High force inertia ratio of hydraulic motor (piston) *permits high performance without overshooting.*

3 • *DEPENDABLE*—Proven ASKANIA design reduces number of moving parts. Self-lubricating, it may be operated in most unfavorable atmospheric and temperature conditions *without expensive and space consuming protective shelters.*

4 • *EASILY, INEXPENSIVELY MAINTAINED*—The force balance system contains only one moving part in the regulator (the Jet-Pipe Relay). Even after periodic inspection is made factory calibration is easily maintained after reassembly.

5 • *PEAK PERFORMANCE*

—Advanced signal system reduces mass and consequently inertia to further improve performance.

New Descriptive Bulletin Provides Complete Information

The new ASKANIA REGULATOR Bulletin #33.2 fully describes the ASKANIA Arc Furnace Control...what it is...how it works... where it is applied...how it is maintained...the advantages it brings to arc furnace operation. Write for your copy to Askania Regulator Company, 246 E. Ontario Street, Chicago 11, Illinois.

ASKANIA REGULATOR COMPANY
"CONTROLS FOR INDUSTRY"
HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

A SUBSIDIARY OF GPE

Outlasts

All Other Refractory Bonding Mortars

IMPORTANT FACTS

• *In Blast Furnaces*

Because it contains but a small percentage of iron found in other bonding mortars, Super #3000 is more resistant to failure of linings due to carbon deposition and alkali attack. Its dried density and abrasion resistance are highest of all. It's stronger than the brick it bonds.

• *In Open Hearths*

Used for laying or patching refractory brick in ladles, spouts and kindred places, Super #3000 greatly increases its life.

• *In Electric Furnaces*

Troweling a ¼" thick layer of Super #3000 against the steel shell, then pushing the brick and bonding them in place against the wet mortar, provides exceptional protection for the shell when molten metal cuts through the brickwork.

• *In Soaking Pits*

Fire brick and tile in soaking pit covers, set up with Super #3000, increase service life of the covers as much as 50%. Recuperator tubes laid up and wash coated with Super #3000 are sealed air-tight.

• *In Coke Ovens*

Pouring new floors or repairing old floors with Super #3000, without cooling down the oven or need for expensive labor, is a short cut that saves thousands of dollars in but a few months.

Ready Mixed
Ready-to-use
Trowels perfectly
to smooth finish

Air sets weld-tight, to highest dried density. It does not spall, shrink or crack at low, medium or high temperatures to 3000° F. Has unsurpassed strength—high heat resistance to flame erosion and mechanical abrasion.

✓Make Your Own Test

Write for generous free sample of Super #3000

Write for brochure

REFRACTORY & INSULATION CORP.

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

136 WALL STREET • NEW YORK 5, N. Y.

cylinder, double-acting, water-cooled machine of semi-radial design, achieving final pressure in two stages.

Three standard single models and three "Twin Unit" models are available, plus corresponding altitude sizes. Twin units consist of two standard compressors powered by one motor. High and low pressure variations of the new compressor are also available. Drive may be by electric motor, either flange-mounted or coupled, or by diesel engine, steam turbine, or turboelectric combinations.

CENTRIFUGAL PUMPS

▲ Allis-Chalmers Manufacturing Co.'s centrifugal pumps are now available with nodular iron casings.

Nodular iron is now being used in pump casings likely to be subject to very high suction pressures as well as units handling corrosive and abrasive materials. Pumps of nodular iron casings are also suitable for handling potentially explosive liquids because of the metal's nonfragmentary properties.

Developed and patented by Allis-Chalmers, nodular iron has considerably more strength and toughness than cast iron. Prices of pumps with nodular iron casings are slightly higher than their cast iron counterparts but considerably less than those with steel casings.

DUST COLLECTOR

▲ Research-Cottrell, Inc., has announced the addition of the Aerodyne dust collector to its line.

A main feature of the Aerodyne is its unusual flexibility. The design of the unit permits maximum efficiency regardless of the size of the installation and the volume of gas handled. The complete unit occupies little space and may be installed in a horizontal, vertical, and even slanting position, which makes it readily adaptable to space available.

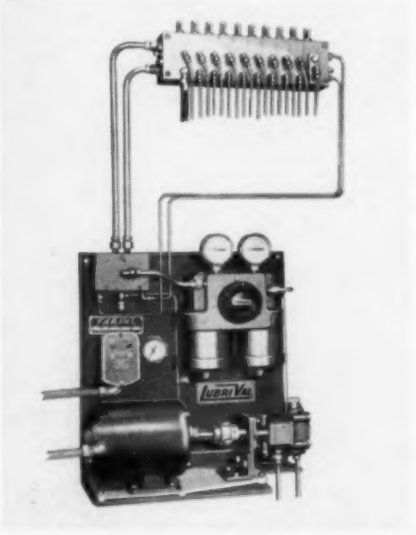
The dust collector works on a unique principle of separation, with aerodynamic force effecting the gas cleaning. An intricately louvered steel sheet shaped in the form of a cone forms the filter surface. As the dust-laden gas passes over the inside surface at high velocity, the resulting aerodynamic forces cause the dust particles to move away

from the face of the cone. Cleaned air escapes through the louvers; at the same time the forward motion of the dust layer carries it to the tapered end of the cone, where it is drawn through the outlet.

CIRCULATING OIL SYSTEM

▲ A new type of circulating oil system to be marketed under the trade-name "Lubrival" has been developed by The Farval Corp.

Designed to serve the lubrication needs of presses, automatic and semi-automatic machine tools, etc., the system employs the two-line principle of operation to supply oil under pressure to measuring valves for delivery to bearing points. The valves have individual sight indicators and feature the positive piston displacement method of feeding lubricant.



Layout presents manifolded group of measuring values (top) connected to reversing valve on control panel. Other components include a high-low pressure switch, reservoir level indicator, ½ hp motor, variable delivery pump and high pressure twin filter. Reservoir and return oil arrangements are determined by the equipment builder or user.

The system monitors its own operation through a pressure sensing mechanism to warn of clogged or broken lines in any part of the system.

For operating flexibility, a variable delivery pumping unit permits a wide range of selection in the number of injections per minute applied to bearing points. There is no limit to the number of measuring valves that can be manifolded together to serve a piece of equipment, and the valves are manufactured in two capacities for interchangeable installation as required. In addition, since each valve is designed to serve two bearings, a simple, external cross-porting accessory can be attached at any time to merge two discharge ports into one. Simplicity of design and soundness of operating principle ensure that temperature-induced changes in oil viscosity have no effect on valve deliveries.

WELDERS

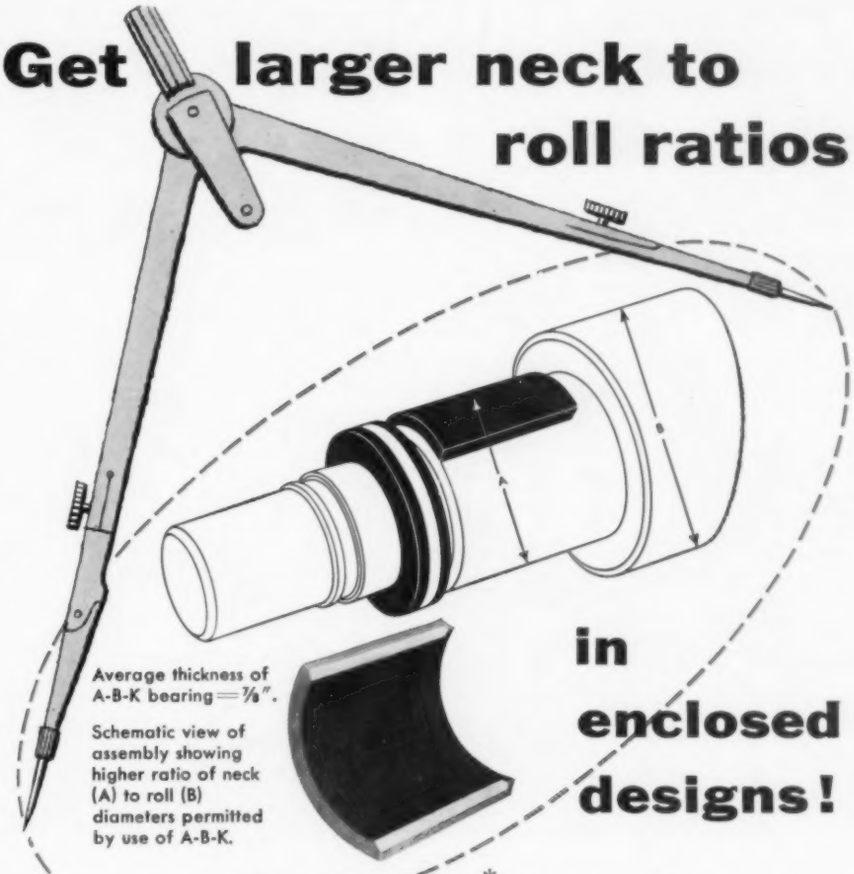
▲ General Electric Co. has announced a new line of motor-generator welders, featuring prelubricated, sealed bearings, controlled current peaks, and space-saving design.

Due to compact, sturdy construction, these welders may be stacked—one atop the other—thus reducing considerable floor space.

An improved magnetic starter

(*Please turn to page 220*)

Get larger neck to roll ratios in enclosed designs!



Schematic view of assembly showing higher ratio of neck (A) to roll (B) diameters permitted by use of A-B-K.

use A-B-K* bearings

No need to sacrifice roll neck diameters to keep down size and cost of bearing assemblies and housings. A-B-K bearings save space, permit larger, stronger roll necks—with cheaper, lighter weight parts. A-B-K laminated phenolic bearings have ability to absorb and cushion heavier impacts, and often outwear metal, many times. Grease and oil can be used for lubrication but water, alone, is often the answer. Ask our engineers for specific recommendations.

- Wear longer
- Won't score or heat check
- Light in weight
- Cut lubricant costs
- Save power

A-B-K
LAMINATED
PHENOLIC BEARINGS

*A registered trade-mark of American Brake Shoe Company in the United States and of Joseph Robb & Company, Limited, in Canada.

American Brake Shoe Company
American Brakeblok Division
DETROIT 9, MICHIGAN

The floor charging machine at left is loading an ingot into a heating furnace. At right is the control panel with ***ElectroniK*** strip chart program controllers.

ElectroniK program controllers automatically regulate soaking and cooling furnaces. These furnaces are also equipped with Honeywell multiple burner ***Protectoglo*** flame safeguard systems. The control cabinet of one of these systems is shown at upper right.

These *ElectroniK* program controllers automatically regulate the heating furnace time-temperature program. The panel also contains two Brown indicating pressure controllers which regulate furnace draft.

Program your time-temperature cycles...

with *ElectroniK* controllers

A large eastern producer of specialty steels uses Honeywell *ElectroniK* program controllers for automatic control of heating and soaking furnaces. These controllers have the flexibility needed for the variety of work handled—stainless and heat-resisting steels, matched tool and die steels, high nickel alloy steels, and special purpose alloys.

In the press shop, where a hydraulic press reduces ingots for rolling, *ElectroniK* strip chart program controllers automatically regulate four heating furnaces and two soaking furnaces. These instruments are ideal for this type of operation because their control point settings, and heating, soaking and cooling rates are easily changed to meet the time-temperature requirements of various kinds of stock.

Where a process calls for *repetition* of a prescribed time-temperature pattern, *ElectroniK* circular chart cam program controllers are used to advantage. Once the program is cut on the plastic cam, it can be repeated over and over again with consistent accuracy.

For time-temperature program instrumentation matched to your own particular requirements, call your nearby Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Aves., Phila. 44, Pa.—in Canada, Toronto 17, Ont.

• **REFERENCE DATA: Write for Catalog 1531, "*ElectroniK* Controllers."**

H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

GOLDEN-ANDERSON VALVES *IN ACTION!*

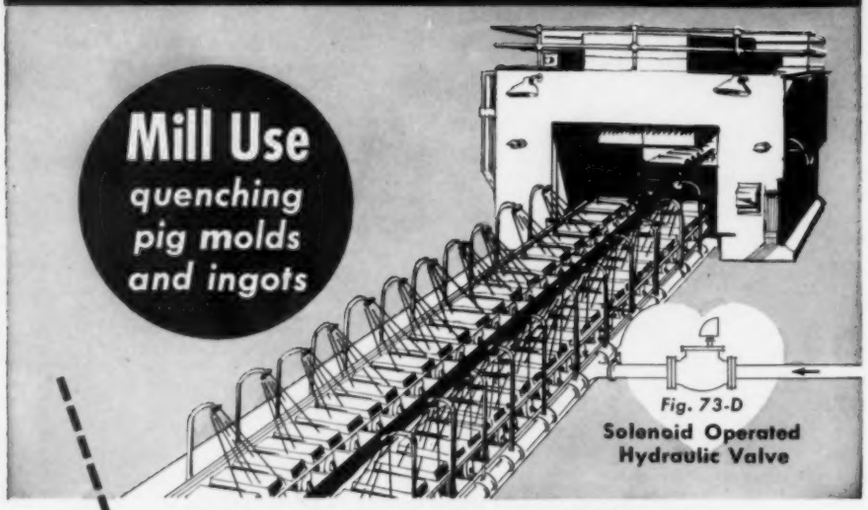


Fig. 73-D
Solenoid Operated
Hydraulic Valve

For automatic quenching of pig molds (illustrated above) or ingots, install the G-A Cushioned Solenoid-Operated Valve. This valve opens quickly, closes at adjustable speed without hammer or shock, is available either normally closed or normally open, and is actuated automatically by push button, trip switch on conveyor, or other type of limit switch.

Available in either Angle or Globe Body Pattern

Write for descriptive technical bulletin W-7A.

Golden Anderson Valve Specialty Company
1220 RIDGE AVE., PITTSBURGH 33, PA.

(*Continued from page 217*)

with fast response, bi-metallic thermal overload relays prevents motor burnout in the event of motor overload. The relays will kick-out in less than ten seconds in stalled single phase, and in less than eight seconds if the rotor is locked in normal three-phase position.

All bearings, which are rubber-mounted for quiet operation, are over-size for longer life. A unique air by-pass in the intermediate bearing housing and a dust cap on the commutator and bearing prevent dust contamination.

The welders produce the same high recovery voltages and controlled current peaks with pop-out-free arcs as engine-driven units.

Built with push-button controls, the new units include generator, driving motor, and accompanying controls, all encased in a weather-resistant, self-ventilated case.

Driving motors and motor starters on dual-voltage machines are designed to accommodate voltage reconnection without changing overload relay heaters and other accessories.

The generator employs the Bergman split-pole principle, and is self-excited from an independent third brush. This design, combined with General Electric transformer reactor, produces a penetrating arc. In addition, control of current surges assures instant high recovery voltage at all settings.

BAR TURNER

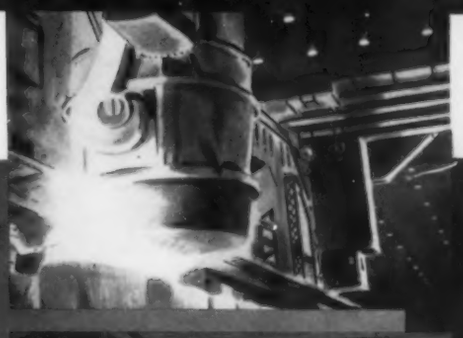
▲ A centerless bar turner for high speed centerless round bar turning with carbon or oxide cutting tools has been announced by the Blaw-Knox Co.

The new machine allows application of the principle of the torque chipper method of centerless turning to bars 4½ in. in diameter. These machines are offered in three sizes, to cover the bar diameter range from ⅜ in. to 6 in.

Key advantages of the torque chipper method are that it combines two functions necessary for successful turning by carbide and oxide tools. The bar is fed into the machine through automatically centering feed rolls. The feed rolls push the bar through a patented "torque chipping" set of tools that absorb the

NEW! For Effective Lighting of High Mounting Areas...

HOLOPHANE HIBAY* Reflector For Mercury Vapor Lamps



Especially Recommended for:

Steel Mills
Foundries
Power Plants
Paper Mills
Machine Shops
Hangars
Armories
Sports Arenas
Field Houses
Gymnasiums

No. 640

Holophane engineers, authorities in the development of lighting for industrial interiors, present another important contribution in this field —a new HIBAY Reflector... Designed for 400 Watt Mercury-vapor lamps... This unit consists of only two parts: (1) ventilated socket yoke; (2) smooth prismatic reflector with sealed metal cover. This simplified construction permits easy installation and economical maintenance. Reflector surface is kept clean by upward draft action induced by open design. Exposed socket assembly assures rated lamp life. Light source is deep-shielded, eliminating glare.

Write for complete engineering data on industrial lighting today.

The name HOLOPHANE is your Surest Guide to LIGHTING QUALITY

Every Holophane product is carefully and individually pressed on specialized equipment. Only by this painstaking process can we make prismatic forms accurate enough to direct light precisely where it is needed. Holophane products provide the basis for custom-engineered lighting systems, specifically designed for each area. To be sure of quality look for the name "HOLOPHANE" impressed on each piece.

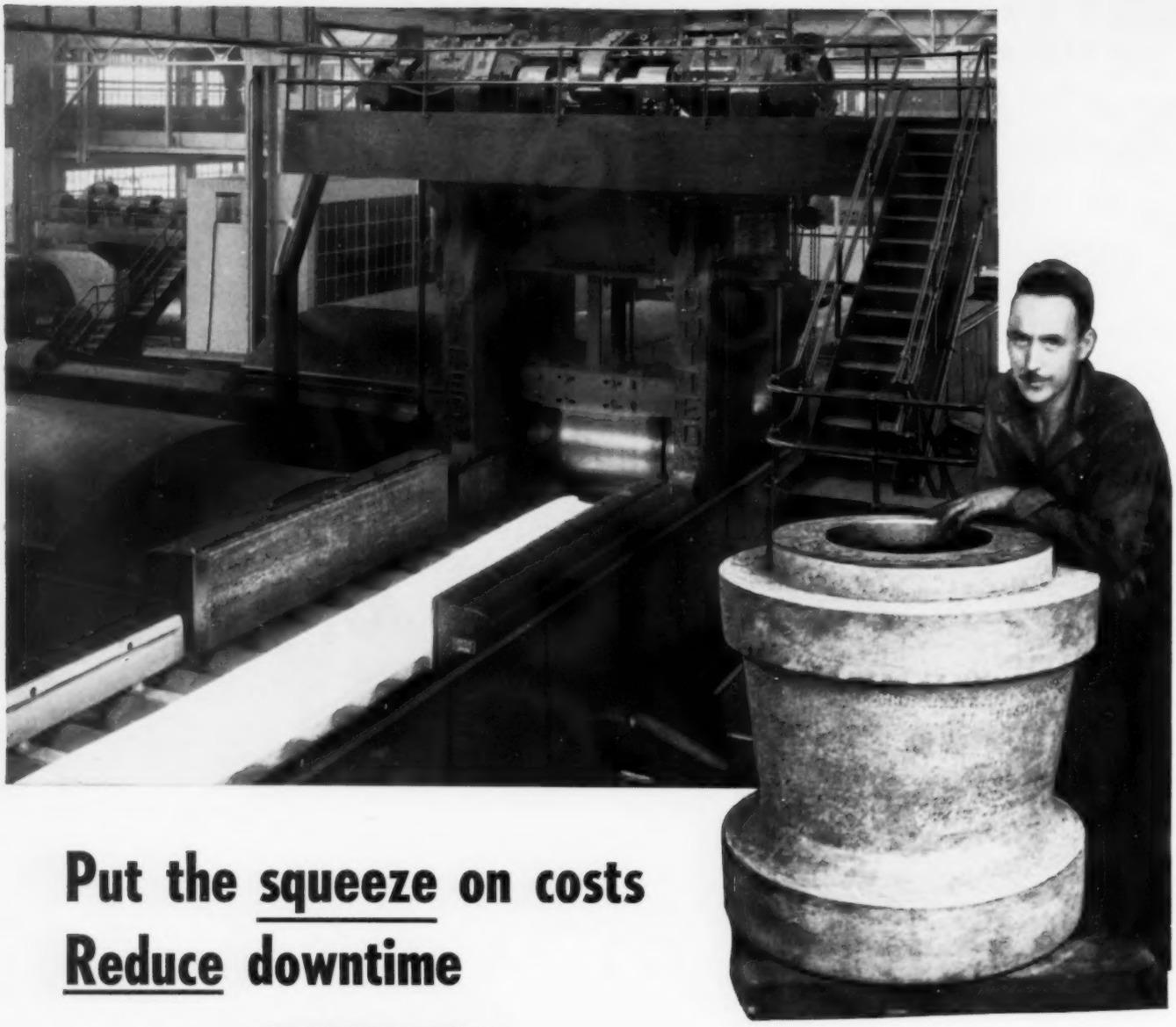
HOLOPHANE

COMPANY, INC. • ***Lighting Authorities Since 1898***

342 Madison Ave., New York 17, N.Y.

THE HOLOPHANE CO., LTD., 418 KIPLING AVE. SO., TORONTO 14, ONTARIO

Holophane *For Better Lighting...Be Specific*



Put the squeeze on costs
Reduce downtime
...use AMPCO*

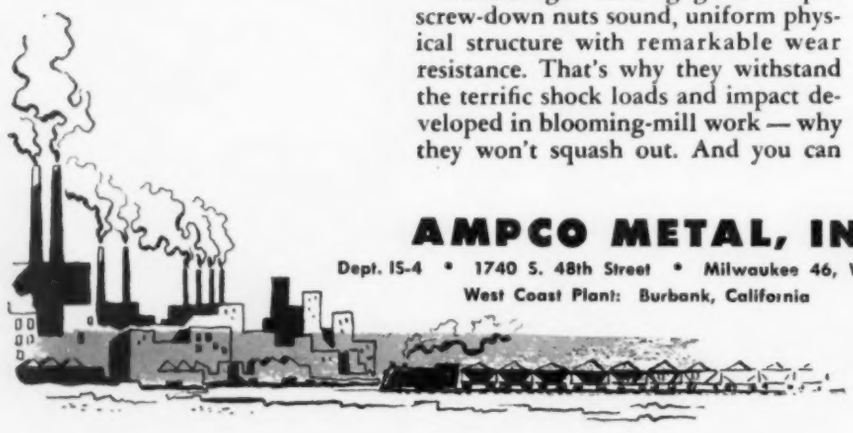
Screw-down Nuts

CUTTING costs is old stuff to Ampco Metal. And when Ampco is centrifugally cast into screw-down nuts for blooming-mills, you find no equal for top performance — lower costs — longer runs.

Centrifugal casting gives Ampco screw-down nuts sound, uniform physical structure with remarkable wear resistance. That's why they withstand the terrific shock loads and impact developed in blooming-mill work — why they won't squash out. And you can get Ampco screw-down nuts in sizes up to 6000 pounds.

Wherever extra toughness and wear resistance is important, you find Ampco Metal on the job — in slippers, wear plates, flash-welding dies. Its high resistance to corrosion saves money for you in pickling equipment and similar applications.

Your nearby Ampco field engineer is glad to give you full information. Contact him today or write us.



*Reg. U. S. Pat. Off.

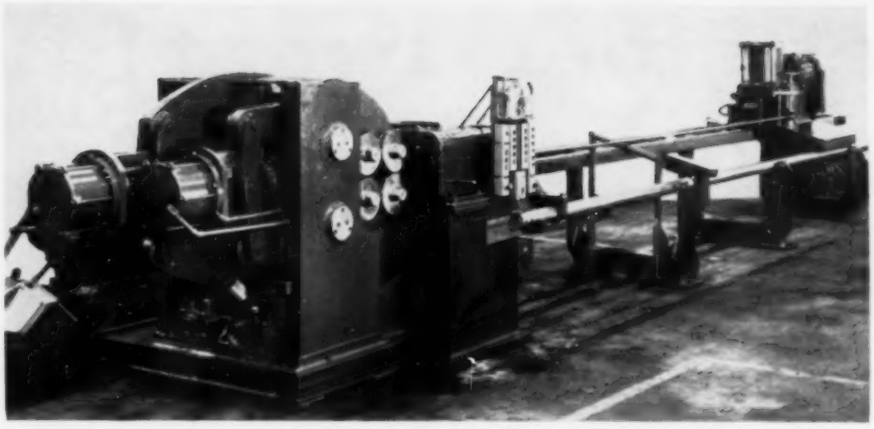
AMPCO METAL, INC.

Dept. IS-4 • 1740 S. 48th Street • Milwaukee 46, Wisconsin

West Coast Plant: Burbank, California

AMPCO®

G-19



Centerless bar turner will turn any type of alloy steel or nonferrous metal, with output reaching 12 ft of finished bar per minute. All material cut from the bar is recovered.

turning torque of the cutting tools and also limit the length of the chip. The three or more cutting tools are carried in a single cutting head arranged so that the cutting is done at the point of bar support.

The bar is gripped on the output side of the cutter head by a power driven grip carriage. This carriage draws the bar through the cutter head so that it is always in tension, a feature that insures successful operation on small diameters.

Any type of alloy steel or nonferrous metal can be turned by the equipment, and all material cut from the bar is recovered. Tests show that output, limited only by the ability of today's cutting tools, has reached 12 ft of finished bar per minute, or higher.

SPRAY NOZZLES

▲ The new Spraying Systems Co. Hollowjet spray nozzles offer a wide range of 1.5 GMP to 1100 GPM, all with a relatively small diameter spray pattern. At 40 lb pressure these nozzles produce a spray with a 30 deg. spray angle. The jet spray nozzles are made in pipe connection sizes from ¼ in. to 5 in. in brass, steel and stainless steel.

These nozzles were designed for a wide variety of applications, where concentration of the pattern area is necessary.

WEATHERPROOF GAGE

▲ Recording gages for pressure, vacuum, and water or liquid level measurements are now available in new weatherproof cases, according to a recent announcement by the Bristol Co.

The new gages are designed for wall or pole mounting outdoors, where they will be subjected to all types of weather. Measurements of water depths or other liquids can be accomplished with float-type, pressure-type, differential-pressure-type, or bubbler-type liquid level gages; pressure gages are offered in all ranges.

Both 8-in. and 12-in. round chart models are available in the new cases; flowmeters and thermometers are also offered.

LIFT TRUCKS

▲ The Yale & Towne Manufacturing Co. has announced the development of an all new line of 15,000 to 20,000 lb capacity gasoline powered, pneumatic tire lift trucks marking the first major design advance in this type equipment since its introduction in 1938.

Among the new features in the G-3 line are the channel construction which provides 300 per cent more visibility for the operator, the achievement of load stability heretofore impossible to obtain in this capacity industrial lift truck equipment, and the fastest possible cyclic rate of operation within the limits of safety.

The line is being introduced in 15,000—16,500—18,000 and 20,000-lb capacity models powered with gasoline or LP-Gas and utilizing either a straight, friction clutch transmission or Fluid Coupling transmission.

In addition to the design innovations, a foremost consideration

COWLES

TRIMMING KNIVES

Assure more continuous production and more tonnage from each grind

Cowles knives stay on the job longer. They keep mills in continuous production with minimum downtime for knife changes. Manufactured from individually hammered forgings, and heat treated to assure maximum durability, they meet industry's most exacting requirements. Any diameter, face or bore. Widely used by all principal producers and processors. ***Let us quote on your requirements!***

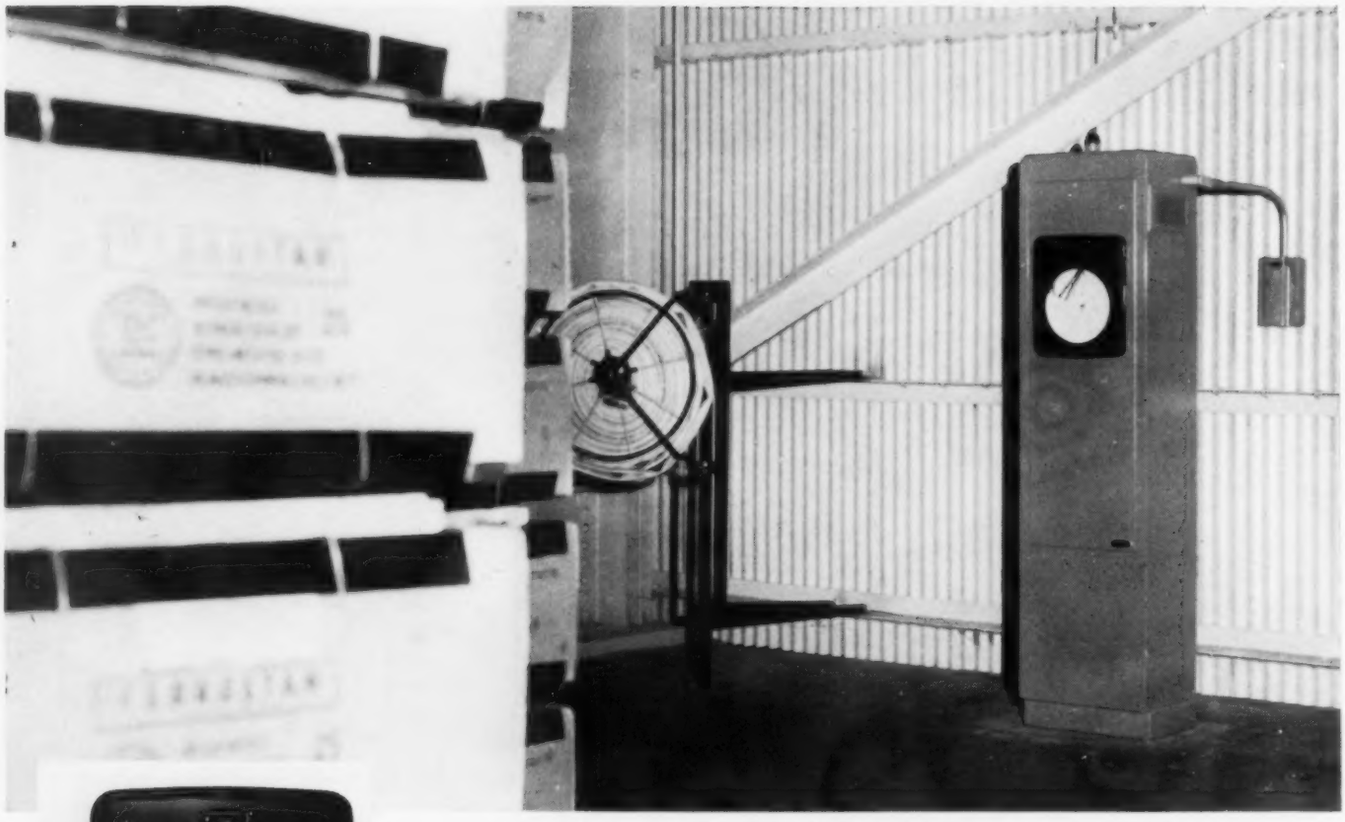
COWLES TOOL COMPANY

2070 WEST 110th STREET • CLEVELAND 2, OHIO

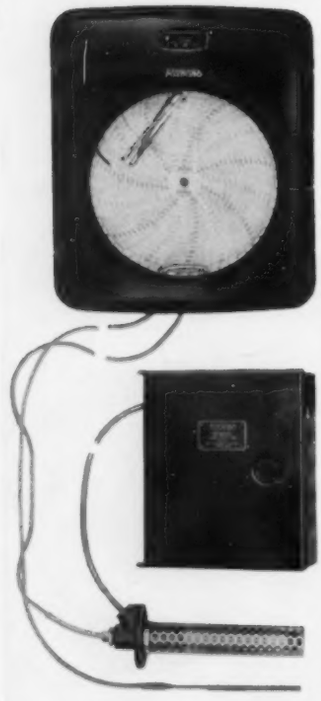
Specializing in the Manufacture of

ROTARY SLITTING KNIVES • SPACING COLLARS • ROTARY TRIMMING KNIVES • ROLL TURNING TOOLS • EDGING ROLLS • CUT-OFF KNIVES STANDARD AND SPECIALLY ENGINEERED TOOLS FOR ALL FERROUS AND NON-FERROUS PROCESSING, TRIMMING AND FORMING REQUIREMENTS.

Don't let steel sweat!



One of three "package unit" Foxboro Condensation Prevention Controllers which continuously guard storage areas in a large eastern steel plant.



. . . prevent moisture damage to stored steel with Foxboro Control

Steel in storage stays dry, resists rust and corrosion, when it's protected by a Foxboro Condensation Prevention Controller. This simple, inexpensive Controller automatically makes sure that air temperature in the storage area is always high enough above the dew-point to prevent costly condensation.

The Foxboro Condensation Prevention Controller employs the exclusive Dewcel* element to measure dew-point, and a dry bulb element to measure temperature. Control action automatically energizes signal devices, or operates valves in the building's heating system to hold air temperature safely above condensation point.

Operation of the Foxboro Condensation Prevention Controller is equally effective from 0° to 120°F. dew-point. It requires no water box or circulation of air — no air sample refrigeration under normal conditions. And there's practically no maintenance. Protect *your* sheets, rolls, and similar materials this modern, economical way. Write for Data Sheet 000-8 or call your nearest Foxboro Field Engineer.

* "Trademark"

← Controller (top) continuously measures and records dew-point. Dewcel "sensing" element (bottom) functions equally well in still or moving air. Instrument in center is Dewcel power unit.

THE FOXBORO COMPANY, 584 NEPONSET AVE., FOXBORO, MASS., U. S. A.

FOXBORO
REG. U. S. PAT. OFF.

CONDENSATION PREVENTION CONTROLLERS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Your BIG machine tools, of every type, are

TOO VALUABLE NOT TO REBUILD

Any machine tool in your plant, of *any* type, and *any* size, can be given a new lease on life and returned to its original tolerances by Simmons *Engineered Rebuilding* . . . at less than half the cost of a new machine tool!

Every day, machine tools which have been literally "worked to death" are brought into the Simmons plant where they are dismantled right down to the bare castings. Every component part is disassembled and inspected. The least flaw that can impair working efficiency is corrected, either by expert machining or replacement.

When completed, your machine is *guaranteed* to fill the specifications of its original builder. The savings are great. Write or telephone today. Your inquiry will receive our immediate attention. Simmons Machine Tool Corp., MAIN OFFICE AND PLANT, 1712 N. Broadway, Albany 1, N.Y. (*New York City Office: 50 East 42 Street, N. Y. 17*)

Write for **THE SIMMONS WAY**

Photo-stories of recent machine tool rebuilding and modernization for major companies.

SIMMONS
MACHINE TOOL CORPORATION

SINCE 1910 . . . *Builders and rebuilders of unconditionally guaranteed machine tools*

achieved in the truck was a ruggedness of construction.

Pilot models of the new equipment have received extensive field testing under severe operating conditions in a variety of industries prior to the introduction of the line.

MARKING UNIT

▲ A rotary hot metal marker, that assures clear, positive hot metal stamping with a minimum amount of time, trouble, and service is available from the Pannier Corp. The wheel has two pockets, located 180 deg apart, which holds quick-change type cartridges. In addition to the economy advantages of faster type changes and pre-set type, the cartridge stamps characters closer together for easier reading. Type cartridges can be inserted and removed with one hand; brake stops rotating wheel quickly for safe, sure cartridge handling. It is not necessary that each pocket stamp the same mark . . . one may stamp heat numbers, for example, while the second pocket is used to stamp the trade mark. The location of the type pockets on the wheel allows an impression every 18 in. or, if one pocket is used only as a space, an impression is made every 36 in., on hot metal products being conveyed by the rotary marking wheel.

Operation of the marker is automatic, exactly timed with the material that passes for stamping, by control mechanisms that actuate either an air or hydraulic cylinder which is attached to power the ram. The outside edge of the wheel can be machined concave, or with a "V" groove, to better suit a curved surface on the material being marked. The wheel (12 in. outside diameter × 4½ in. thick) has internally sealed antifriction bearings mounted on a 2 in. diameter steel post.

Book Reviews

"The Procedure Handbook of Arc Welding Design and Practice" has just been issued in a completely revised eleventh edition covering information on all phases of arc welding. Over 1300 pages with 1100 illustrations, pictures and charts; 6 x 9 in. size; gold embossed simulated leather cover; the price is $3.00, postpaid in U.S.A., and $3.50 elsewhere. It may be obtained from

A COMPLETE REFRACTORIES SERVICE . . .

for the Steel Industry

OLIVE HILL BF and OLIVE HILL HI-FIRED brick rank high in any list of prominent and widely used brands of blast furnace refractories. Manufactured from dense-burning Kentucky flint fire clays by Grefco's unique manufacturing processes, OLIVE HILL brick set a standard for blast furnace refractory quality and workmanship.

Grefco processing of OLIVE HILL brick entails:

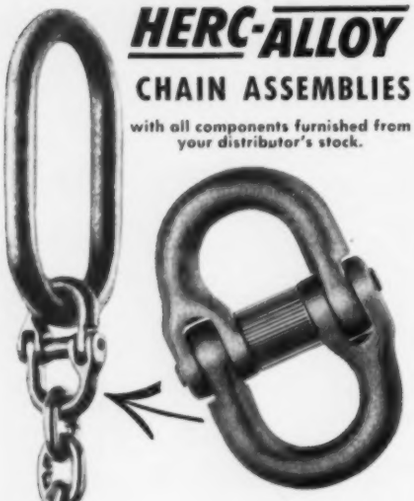
1. Careful selection, testing, stockpiling and blending of fire clays to insure uniform raw material quality.
2. Grinding and screening to prescribed formula to promote high density of product.
3. Efficient deairing during brick forming, also to promote density and proper physical structure.
4. Careful firing to exacting temperature schedules yields uniform high quality brick.
5. Close inspection of final product with gauging and sorting of brick to close size tolerance.
6. Quality control by statistical analysis procedures for the manufacturing processes.

In service, OLIVE HILL blast furnace brick, both BF and HI-FIRED, have produced many splendid performance records in the past. OLIVE HILL linings in presently operating furnaces, are giving outstanding performance and are more than meeting the increasing requirements of the expanding American Iron and Steel Industry.

GENERAL REFRACTORIES CO.
Philadelphia 2, Pa.

GENERAL REFRACTORIES

MAKE YOUR OWN
HERC-ALLOY
CHAIN ASSEMBLIES
with all components furnished from your distributor's stock.



CM
Hammerlok®
COUPLING LINK
• NO PEENING
• NO WELDING
• Hammerlok is made of alloy steel . . . is stronger than Herc-Alloy chain . . . is thoroughly field tested.
• Write for literature or ask your industrial distributor about Hammerlok.
• Made by the makers of Herc-Alloy . . . the original alloy steel chain.
COLUMBUS McKINNON
CHAIN CORPORATION
TONAWANDA, NEW YORK
DISTRICT OFFICES: NEW YORK
CHICAGO • CLEVELAND
In Canada: McKinnon Columbus Chain Limited, St. Catharines, Ontario

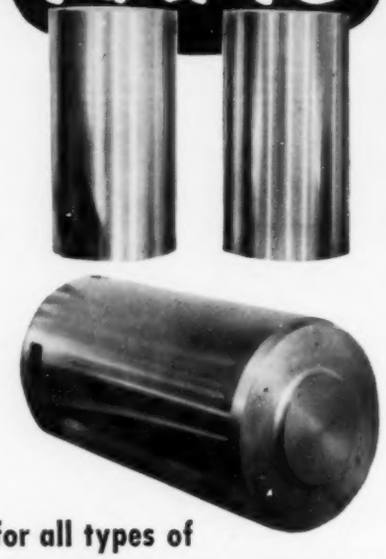
CM
HOISTS AND CHAIN

the publisher, The Lincoln Electric Company, Cleveland 17, Ohio. The book is arranged and written as a reference book covering all phases of arc welding. The contents range from the early history of arc welding to the intricacies of structural design. The eight sections are divided by subject matter for easy study. Each section has its own table of contents, and there is a complete alphabetical index for the entire book. The eight sections are: history, nomenclature and processes, weldability, mild steel procedures, manufacturing cost data, machine design, structural design, applications and reference data.

"Deformation and Flow of Solids" edited by R. Grammel has recently been published by Springer-Verlag, Reichpietschufer 20, Berlin W 35, Germany. The book contains 324 pages, 9 x 6 in., is cloth bound, and sells for 37.50 DM. The book is comprised of the lectures given at a colloquium held in Madrid, September, 1955, by the International Union of Theoretical and Applied Mechanics (UTAM) and the most important discussions. The colloquium was divided into three sessions: dislocations and plasticity (presented in 181 pages); non-linear elasticity (composed of 50 pages); and viscoelasticity and relaxation (72 pages); each introduced by a general lecture, and lists participants from Belgium, Germany, France, Great Britain, Israel, Netherlands, Saar, Sweden, Spain, Soviet Russia, and the United States. The main aim of the colloquium was to unite two groups of scientists separately engaged in research of solids, solid state physicists and research workers in mechanics, whose future cooperation is required for further progress in the field. The book contains 188 figures.

"Spectroscopy at Radio and Microwave Frequencies," 5½ x 8¾ in., 332 pp., price $15.00, by D. J. E. Ingram has been published recently by the Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y. The book contains a general outline of the subject, based on a broad approach stressing the similarity and interrelation of the different branches, as well as their general setting in spectroscopy as a whole. Considerable space has been given to the design of experimental

Hyde Park
RAMS



for all types of
HYDRAULIC EQUIPMENT

Hyde Park Rams are available in Chilled or Alloy Iron.

Furnished in hardness range to meet your specification . . . ground to your required size.

On your next replacement of Rams — or for new equipment—consult us. Our engineers will be glad to assist you.

Red Circle Rolls for every Purpose
Rolling Mill Equipment
Gray Iron Castings up to 80,000 lb.

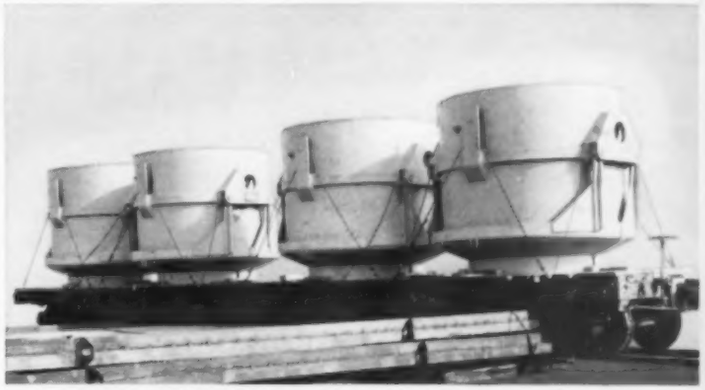
Hyde Park
FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland Co., Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

STEEL PLATE *Fabricating Facts!*

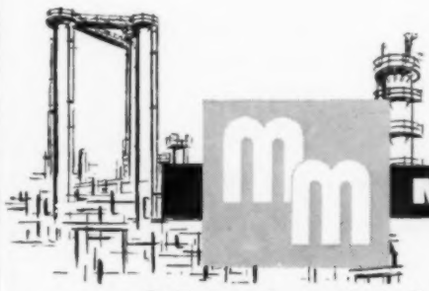
McGREGOR-MICHIGAN Brochure Describes Diversified Facilities and Production

In this compact 12-page brochure you'll find valuable information on McGregor-Michigan's equipment and typical steel plate fabrications. It shows scenes in our new 30,000 square foot Heavy Fabricating Plant and our original Rivard plant. It describes some of our new equipment including a 650 ton press brake and our 600 ton "Bulldozer" horizontal forming press capable of forming heavy beams or solid sections. In addition you'll find clear illustrations of steel plate fabrications for the primary metal producers—ladles, buckets, hooks, doors, water-cooled roof rings and others—and equally interesting chemical and petroleum processing equipment—ASME Code vessels, autoclaves, heat exchangers, kettles and tanks. Many of these assemblies run to 50 tons and over, in mild, stainless and alloy steels. Typical miscellaneous industrial fabrications shown are engine beds, bases for machines, jigs and fixtures, heavy-wall cylinders, foundry cupola shells, furnace casings, a self-propelled sewer tunnel shield and a heavy boom for a power shovel. The brochure also describes our plate warehousing and specialized surface treating services.

We would appreciate your including this informative booklet in your file of fabricating sources. Please send for a copy and the name of our representative nearest you or call direct for prompt service on any steel plate fabricating problem.



Clam shell charging buckets destined for leading West Virginia aluminum plant.



AMERICAN STEEL BETTER DISTRIBUTION WAREHOUSE ASSOCIATION

SINCE 1841

McGREGOR-MICHIGAN CORPORATION

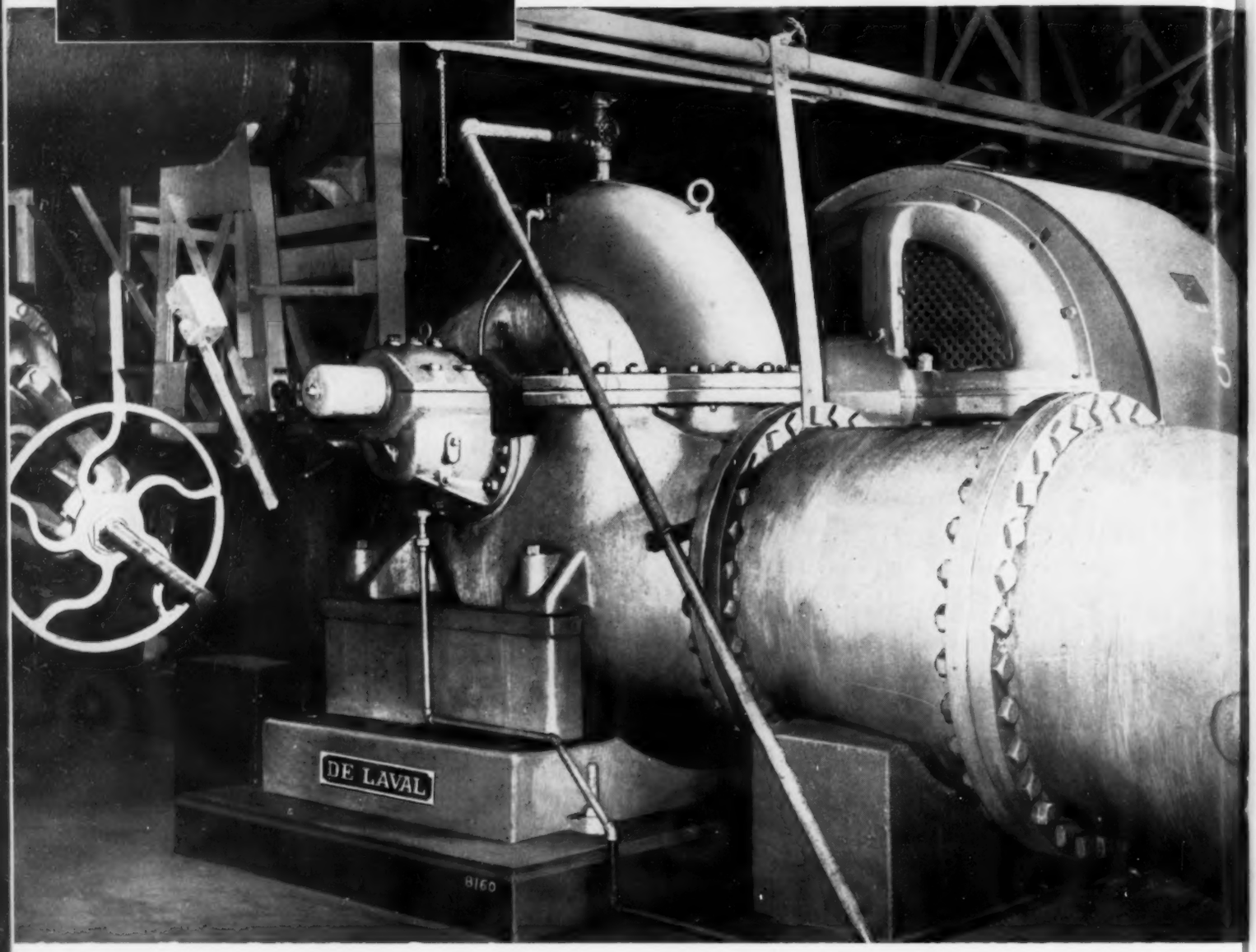
5820 RIVARD • DETROIT 11, MICHIGAN

TRINITY 2-2400

STEEL PLATE FABRICATING AND WAREHOUSING

DE LAVAL
CENTRIFUGAL PUMPS

in service since 1911 at Inland Steel Co.



De Laval Centrifugal Pumps have a record of dependability at the Inland Steel Co., which goes back forty-five years. In that time, De Laval has supplied this major producer with pumps for practically every steel mill service—*more than 75 units in all.* The photograph shows one of the largest De Laval pumps on the line at the East Chicago, Indiana plant of Inland Steel. The unit delivers 20,000 gpm at 120 ft head.

De Laval Centrifugal Pumps are available for a wide range of applications in all types of metal-working plants. Types L, M and P single stage double suction pumps can handle capacities from 1,000 to 20,000 gpm and heads to 350 feet. Larger De Laval units of any capacity to meet any requirement for steel mill service are available.

Send for Bulletin 1004 giving performance and application data.

DE LAVAL *Centrifugal Pumps*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

L-368

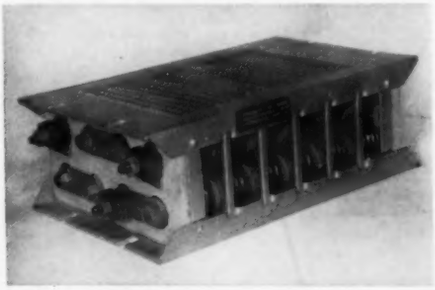
GUYAN
RESISTORS

Engineered and designed to eliminate resistor maintenance on troublesome mill applications.

Non-breakable helical coil construction ends burnouts due to warping and buckling of grids.

Sturdy, rugged steel construction eliminates shock and vibration troubles.

Custom designed for your conditions including excessive graphite accumulations.



With a quarter century of resistor engineering, we invite you to take advantage of our experience.

For complete information on Guyan Resistors, please contact the nearby Guyan Representative or our main plant at Logan, W. Va.

Baltimore, Md.—Durling Electric Co., 2505 St. Paul St.

Birmingham, Ala.—Ebbert & Kirkman Co., 2313 6th Ave. So.

Buffalo, N.Y.—Buffalo Electric Co. West Mohawk St.

Chicago, Ill.—John K. Byrne, 1515 W. Howard St.

Cleveland, Ohio—Mechanical Equipment Co., 3100 Prospect Ave.

Detroit, Mich.—Plant Equipment Co., General Motors Bldg.

Philadelphia, Pa.—George I. Wright 811 Commercial Trust Bldg.

Pittsburgh 27, Pa.—P. R. Holden, 4860 Elmwood Dr.

●

GUYAN MACHINERY COMPANY

LOGAN, W. VA.

apparatus and equipment. Detailed mathematical treatment has been avoided. Diagrams, tables, equations, etc., are employed throughout the book; numerous references are cited, and both an author index and subject index are included.

"Bearing Design and Application" by Donald F. Wilcock and E. Richard Booser has been published recently by McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N. Y. The book contains 464 pages, 9 x 6 in., is cloth bound, and sells for $12.50. The book is divided into three parts: general considerations, rolling bearings, and sliding bearings, and deals with bearing selection and design, emphasizing selection and calculation methods for integrating the bearing design, material, and lubricant into a workable unit. Such phases as analysis of load capacity, speed, temperature, dimensional tolerance, and lubrication factors in selecting ball and roller bearings; combination of the latest digital computer analysis with bearing material and lubricant selection in hydrodynamic journal and thrust bearings; reciprocating bearing design methods for automotive and diesel use; and lubrication system designs are all covered. Featured is the coverage of systematic trouble-shooting techniques for analyzing and eliminating difficulties. Also contained are explicit equations for design procedures with frequent numerical examples; line drawings, tables, photographs. The application problems cover almost all types of industrial equipment: turbine, motor, automotive, appliance, and aircraft and military units.

"Machine Trades Blueprint Reading" by Ihne and Streeter has been published recently by the American Technical Society, 848 East 58th Street, Chicago 37, Ill. The book contains 172 pages, 8½ x 11 in., in heavy paper cover, and sells for $2.95. The book is instructional in nature, covering such subjects as visualization, understanding of various views; reading working drawing; understanding supplementary information; using special view and assembly drawings; reading industrial blueprints. One chapter consists of a large quantity of fine industrial prints, each with a full page question sheet.

PREVENTIVE MAINTENANCE

FOR PIPE, PIPE JOINTS, FITTINGS, COUPLINGS, TANKS, TIE RODS and CONDUIT... ABOVE and BELOW GROUND

STEEL MILLS DEPEND ON

TAPECOAT®

...The Quality Coal Tar Coating in Handy Tape Form

For your preventive maintenance program on mill lines, you need the best possible protection at lowest possible cost. Since 1941, TAPECOAT has proved its superiority in combating corrosion in this type of service. This quality coal tar coating in handy tape form resists moisture, acids, alkalis, chemical fumes, and other severe corrosive and abrasive conditions. Here's low-cost protection for pipe around quenching stations, pickling vats, and wherever any combination of elements create corrosive hazards.

TAPECOAT is self-bonding, easy to apply with the use of a torch. No skilled help is required. It is low in cost considering its high quality and continuing protection which cuts maintenance and replacement expense.

TAPECOAT comes in rolls of 2″, 3″, 4″, 6″, 18″ and 24″ widths. Also available in asphalt.

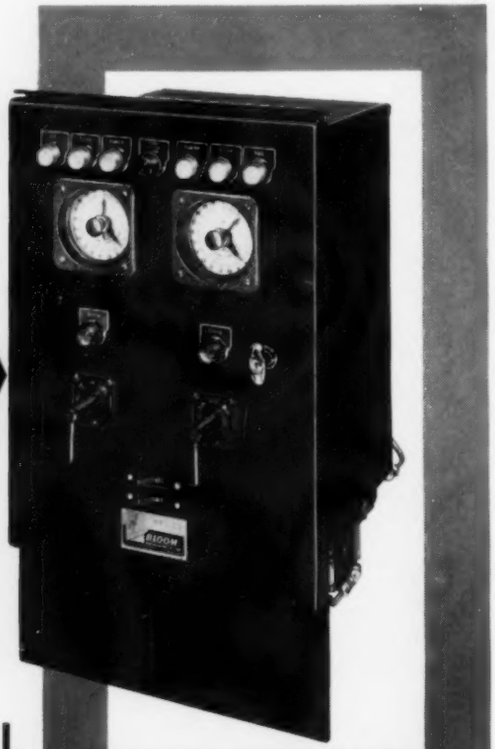
Write for brochure and prices

The TAPECOAT Company
Originators of Coal Tar Coating in Tape Form
1529 Lyons Street
Evanston, Illinois

"The Plastic Methods of Structural Analysis" by B. G. Neal has recently been published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 353 pages, 5½ x 8½ in., is cloth bound, and sells for $7.50. This book discusses plastic methods of analysis including such subjects as basic hypotheses; simple cases of plastic collapse; plastic collapse—basic theorems and simple examples; general methods for plastic design; estimates of deflection; factors affecting the fully plastic moment; minimum weight design; and variable repeated loading. The book also contains four appendices—plastic theory and trusses; plastic moduli of British standard beams; proofs of plastic collapse theorems; proof of shake-down theorem; and, in addition, contains the answer to examples, author index and subject index. Numerous line drawings and tables are employed to explain and substantiate the text.

"Arcs in Inert Atmospheres and Vacuum" edited by W. E. Kuhn has been recently published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 188 pages, 8½ x 11 in., is cloth bound and sells for $7.50. This publication has the papers presented at the Symposium on Arcs in Inert Atmospheres and Vacuum of the Electrothermics and Metallurgy Division of The Electrochemical Society, April 30 and May 1, 1956, San Francisco, Calif. The contents are divided into four sections. The first section consists of a paper "The Past, Present, and Future of Controlled Atmosphere Arcs" by W. E. Kuhn. The second part, arc melting fundamentals, is comprised of four papers: "Arc Properties in the Five Rate Gases" by H. S. Morton and R. M. Gage; "Characteristics of Consumable Electrode D.C. Arcs in Argon, Helium and Vacuum" by E. W. Johnson, G. T. Hahn, and Robert Itoh; "The Effect of Variables on the Melting Rate of Metals in the Consumable Electrode Arc Furnace" by W. H. Smith; "Effects of Magnetic Stirring on Titanium Ingot Quality" by D. E. Cooper and R. J. Krieger. Part III, design and operation of arc melting furnaces contains five papers: "A Vacuum Arc Melting Furnace for Refractory Metals" by O. Z. Rylski and H. V. Kinsey; "A Pilot-Model, Three-Phase, A.C. Consumable-Electrode Arc Furnace" by P. C. Magnusson, G. L. Schmidt, F. Caputo, and R. A. Beall; "Electrode Control Systems for Inert Atmosphere and Vacuum Arc Furnaces" by E. J. Boorebach; "Vacuum Remelting of Superalloys and Steels by the Consumable Electrode Process" by W. W. Drykacz, R. S. DeFries, and R. K. Pitler; "German Developments in the Vacuum Arc Melting of Titanium and Zirconium" by Helmut Gruber. Chemical applications in arcs, Part IV, has four papers: "Energy Transfer in High Intensity Arc.I. A Steady State Treatment of Endothermic Processes Near the Anode Surface" by M. A. Marquis, Laurence Mead, Samuel Korman, and Charles Sheer; "Energy Transfer in the High Intensity Arc.II. Quality Theory of the Anode Sheath" by Laurence Mead, M. A. Marquis, Charles Sheer, and Samuel Korman; "The High Intensity Arc in Process Chemistry" by Charles Sheer and Samuel Korman; "The High Intensity Arc: Electrode Requirements for Metallurgical Application" by Samuel Korman and Charles Sheer. Numerous illustrations are used to support the papers, including photographs, line drawings, tables, and examples.

The BLOOM Time-Cycle Reversal Unit

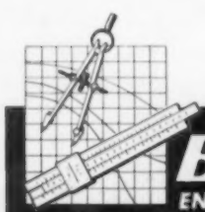


assures FULL, FAST AND EFFICIENT REVERSAL OF REGENERATIVE FURNACES AUTOMATICALLY

This complete, compact, factory-tested unit provides a combination electric-pneumatic system for Open Hearth Furnace and Soaking Pit reversal. It elimnates reversal puffing and shortens reversal period. (10 to 15 seconds easily accomplished).

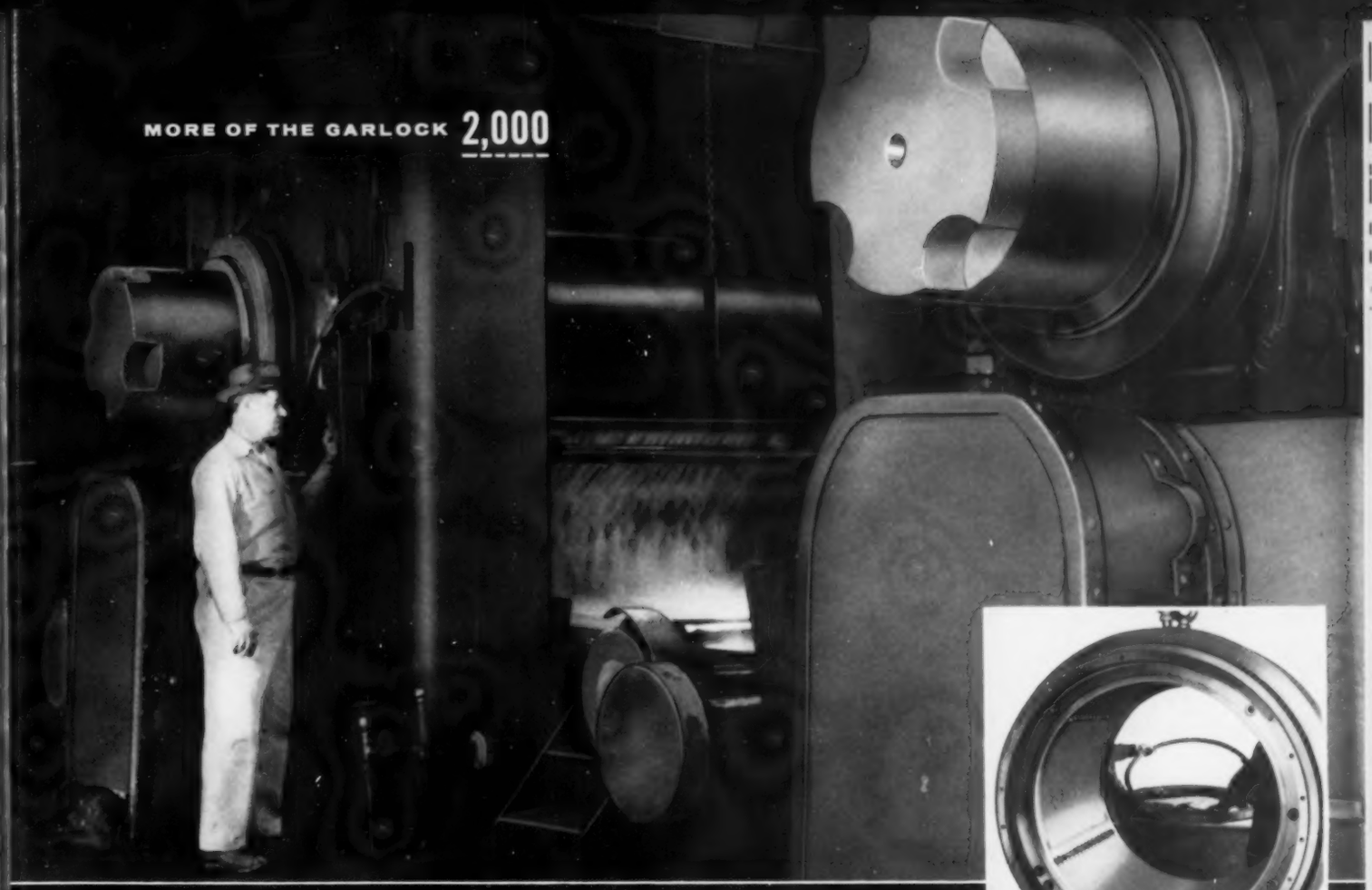
Shorter reversal cycle improves furnace life.

These units have been in continuous service for nine years. Trouble-free maintenance.



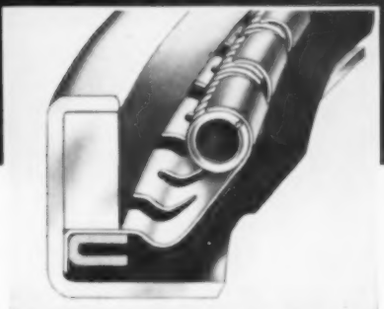
BLOOM ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

WRITE or phone for complete information on the Bloom Time-Cycle Reversal Unit.



YOUNGSTOWN Equips Hot Strip Mills with Garlock KLOZURE* Oil Seals . . . SAVES OIL and MAINTENANCE TIME

Photo shows roll bearing in foreground with KLOZURE Oil Seal and retainer ring removed. In background a new KLOZURE Oil Seal is quickly inserted in retainer ring.



Cross section of Model 64 KLOZURE Oil Seals used on back-up rolls of steel mills.

Nine back-up rolls on the Hot Strip Mill illustrated have been equipped by Youngstown Sheet & Tube Company with 72 Garlock KLOZURE Oil Seals. The rolls run at speeds of 1025 ft. per min. Oil pressure is approximately 8 psi. at temperatures to 120° F.

Youngstown is able to roll a half a million tons of steel on this Mill before the KLOZURE Oil Seals need replacement. Furthermore, considerable maintenance time is saved when replacement seals are applied.

Also, a large percentage of oil has been saved due to the application of Garlock KLOZURE Oil Seals.

If you have an application that requires oil seals, why not investigate the advantages of KLOZURE Oil Seals. They are another important part of "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals for every need. It's the only complete line . . . that's why you get unbiased recommendations from your Garlock representative. Call him or write for KLOZURE Catalog .

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

**Registered Trademark*

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

"No secondary cleaner required with a P-A Washer"

...says FURNACE SUPERINTENDENT

This economical feature of the Pease-Anthony washer is only one of the many reasons why P-A is first choice with blast furnacemen.

It's a "natural" where high top pressures are used . . . puts full top pressure to work cleaning gas . . . low water consumption . . . low initial cost with minimum maintenance requirements . . . compact design requires little space.

Units available for capacities ranging up to 150,000 SCFM. Write for descriptive bulletin.

Performance summary of some P-A Washers now in use:

Installation	Years Operated	Volume SCFM	Pressure Drop Inches Water	Dust Loading Grains/SCF Inlet	Outlet
A	4	78,000	30	3-19.0	.01-.04
B	3½	78,000	30	2-3	.02-.08
C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
H	½	90,000	29	—	.04

Installation C is in Illinois. Installation H is in Texas. All others are in Pennsylvania.

*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure.

CHEMICO

P-A GAS SCRUBBERS

CHEMICAL CONSTRUCTION CORPORATION

A Subsidiary of Electric Bond and Share Company

525 West 43rd Street, New York 36, New York
Telephone LOngacre 4-9400

Technical Representatives Throughout The World
Cable Address: CHEMICONST, N. Y.

Pulpit in plant of Granite City Steel Corporation, Granite City, Ill., air conditioned by Lintern Aire-Rectifier—*Photograph, courtesy of Steelways, official publication of the American Iron and Steel Institute.*

by Air Conditioning Pulpits — and Crane Cabs — you achieve FULL USE OF CAPITAL EQUIPMENT

The Lintern "Split System" Aire-Rectifier allows for a minimum of space-consuming equipment within the pulpit, provides thoroughly cooled, dehumidified even air distribution throughout the pulpit without costly space-using air ducts.

Condensers are located adjacent to the pulpit, connected to the cooling coils within the pulpit by small, easily concealed, flexible refrigerant lines. A majority of the parts are interchangeable with Lintern Crane Cab Conditioners, minimizing the number of different spare parts required.

MEN GET MORE DONE

Regardless of ambient temperatures, this Aire-Rectifier provides a constant, uniform temperature of 80° to 85° — winter and summer — and freedom from fumes and gases. It means higher output per man and low labor turnover.

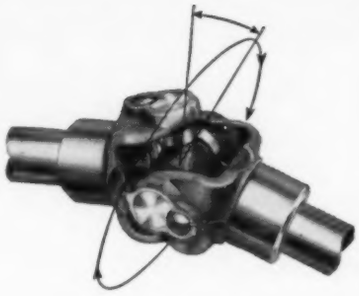
No matter what the temperature — how hot or how cold — the Lintern Aire-Rectifier works efficiently. An absolutely dependable unit, it operates with a minimum of maintenance. *It assures full use of costly capital equipment.*

Ask for new Air Conditioning Bulletin AC-573.

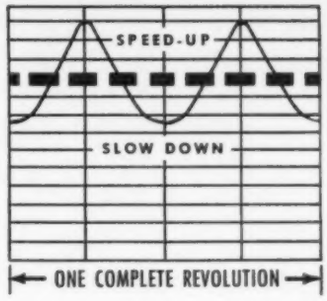
Larco, inc.
DISTRIBUTORS OF LINTERN CORPORATION PRODUCTS
ROUTE 20, EAST • PAINESVILLE, OHIO

FACTS...

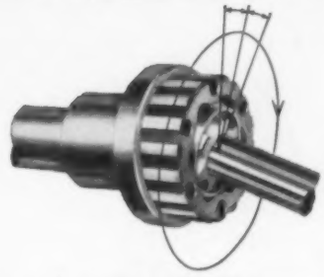
on a Universal Joint that cuts costs, increases production in steel-making equipment



During rotation at a given angle, pin- or slipper-type joint speeds up, slows down twice during one revolution.



Solid line shows speed variation for one revolution of pin- or slipper-type joint at a critical angle. Note constant velocity of 100% for Rzeppa Joint (dotted line).



Due to its construction features, the Rzeppa Joint always transmits a smooth flow of power even at unbalanced angles. The standard joint cannot meet this test without involved compensating measures.

IN THESE TYPICAL APPLICATIONS

Among the many applications where Rzeppa Constant Velocity Universal Joints are ideally suited are:

- Blooming Mills
- Billet Mills
- Merchant Mills
- Skelp Mills
- Butt Weld Pipe Mills
- Electric Weld Tube Mills
- Hot Strip Mills
- Cold Reduction Mills
- Auxiliary Equipment

The above facts prove why you can expect superior performance when your steel-making equipment utilizes Rzeppa Constant Velocity Universal Joints. Rzeppa's *modern design* offers you all these advantages:

- INCREASED SPEEDS
- REDUCED DOWN-TIME
- LOWER MAINTENANCE
- HIGHER CAPACITIES

The next time you are considering universal joints for replacement or original equipment—why not look into the exclusive features offered only by Rzeppa.

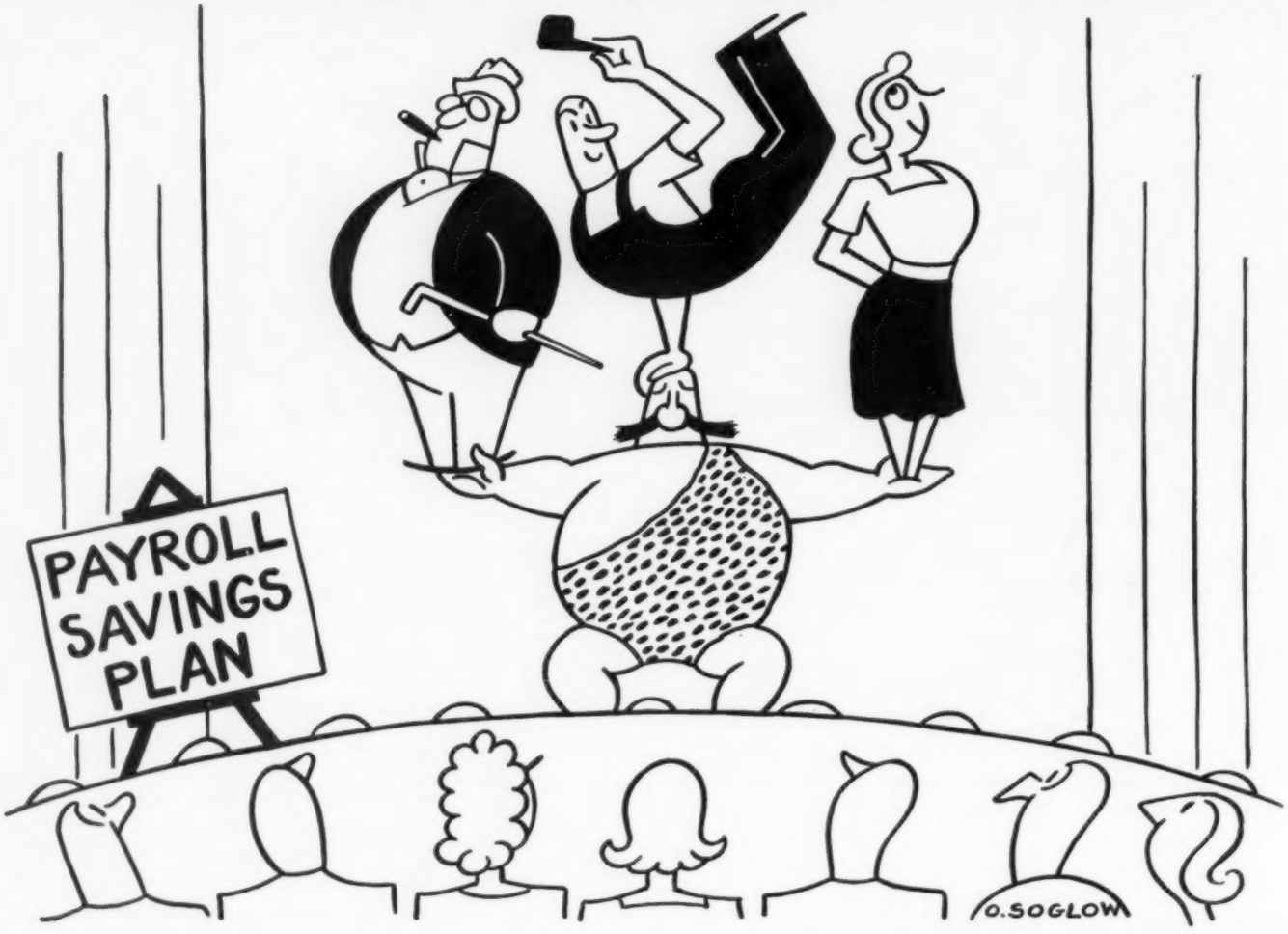
WRITE TODAY . . . for this complete brochure which offers you many more FACTS on Rzeppa Constant Velocity Universal Joints.

RZEPPA

("SHEPPA")
CONSTANT VELOCITY
UNIVERSAL JOINTS

THE GEAR GRINDING MACHINE COMPANY
3929 CHRISTOPHER, DETROIT 11, MICHIGAN
Manufacturers of: Fully Automatic Gear Grinding Machines • THE DETROIT SCREWMATIC 750

"Got A Load On Your Mind? I Haven't"



Nothing gives employees a more luxurious, satisfied feeling than that of financial security. And nothing is easier for them to achieve when you provide the convenience of automatic Payroll Savings Plan.

EVERYBODY BENEFITS

Security breeds confidence—and confidence stimulates job interest and results in steadier people who are far more efficient in their work. Receiving those crisp Bonds at regular intervals along with their paycheck is an added inducement for employees to stay on the job.

Moreover, when you install the Payroll Savings Plan in your company, you promote not only the security of your personnel but the security of your company and your country. Over forty million Americans have over 40 billion dollars invested in United States Savings Bonds—a backlog of purchasing power for the future.

EASY TO INSTALL

If your company does not now have a Payroll Savings Plan, or if employee participation is less than 50%, a letter to: Savings Bonds Division, U. S. Treasury Department, Washington, D. C. will bring prompt assistance from your State Director. He will provide application cards, promotional material, and as much personal help as you need.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

IRON AND STEEL ENGINEER

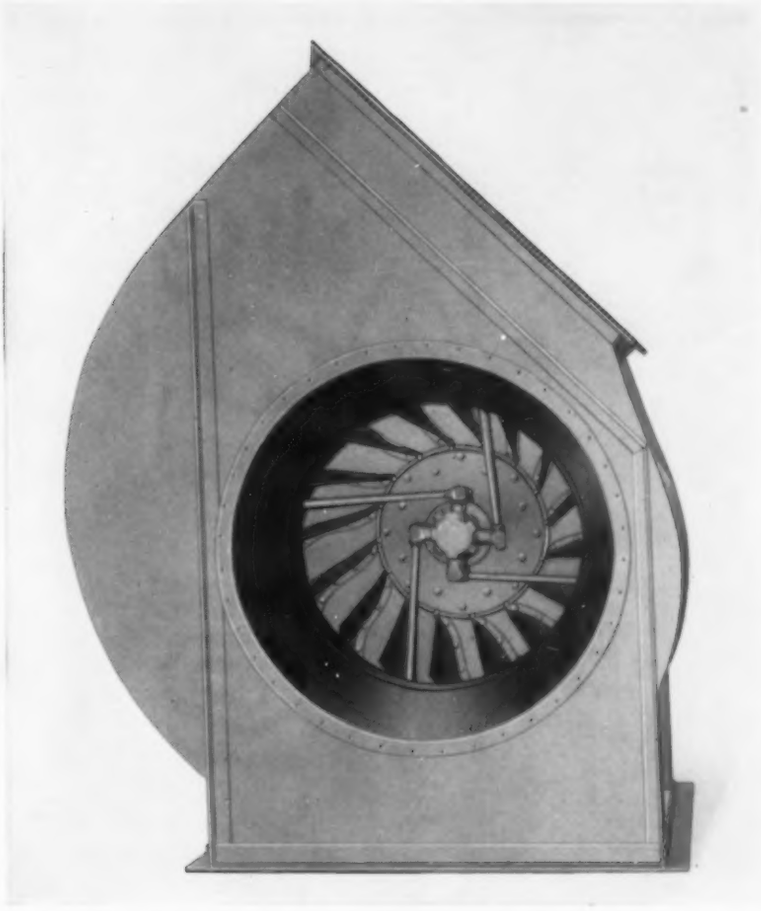
"Buffalo"

CORROSION-RESISTANT FANS WILL SAVE YOU

1. High replacement costs

2. Frequent repair costs

3. Fan down-time costs



"BUFFALO" RUBBER-LINED EXHAUSTERS like this have proved their fume-handling economy for many years in the chemical and metallurgical industries. For full details, write for Bulletin 2424-F.

"Buffalo" Rubber-Lined Exhausters handling corrosive fumes outlast ordinary steel plate exhausters 3 to 12 times—a saving that pays for the cost of the rubber lining in a short time, without counting the down-time saved.

In these fans, every part in the air stream is covered by a skin of rubber "welded" to the steel surface. The fumes never contact the metal. It's that simple—and that effective.

These corrosion-defying fans are just one of a large selection of specialized "Buffalo" industrial fans. Others include stainless steel, coated steel and fiberglas. There's one made-to-order for your particular air handling need—efficient, durable, proven on the job.

Write us about your fume handling or other air application. We'll make recommendations based on long experience and the complete "Buffalo" line of quality industrial fans.

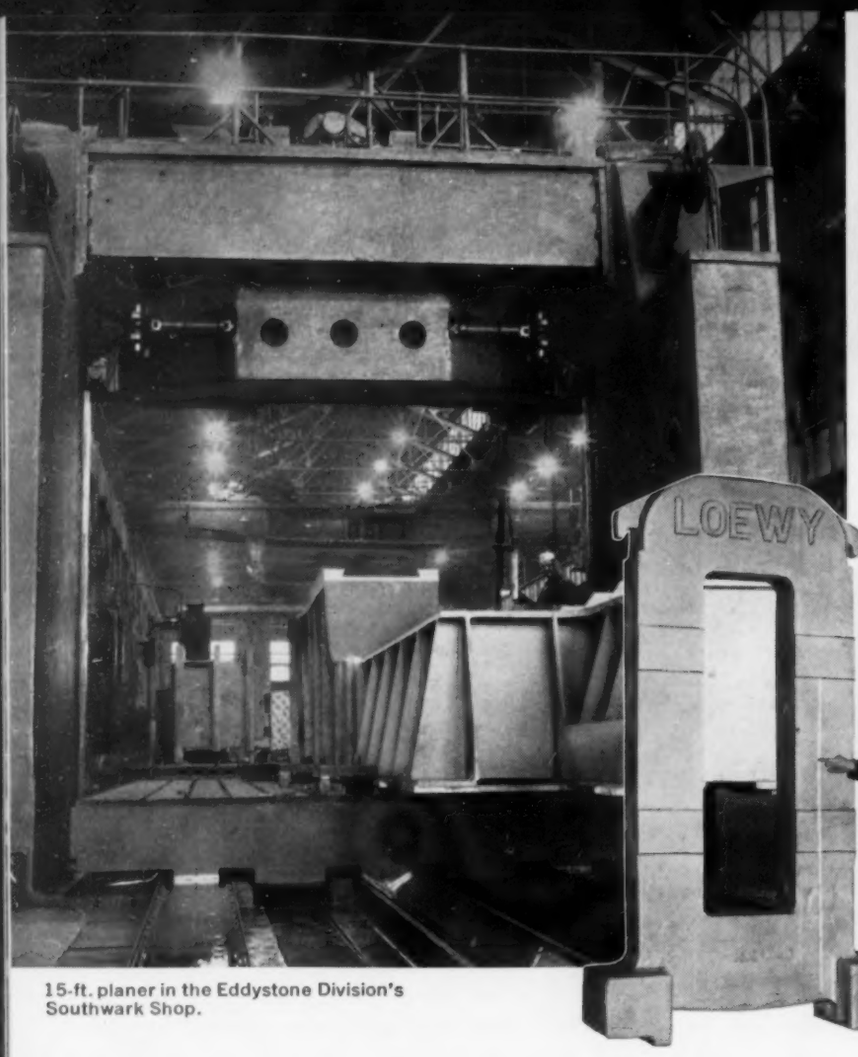
"Buffalo"

BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd. Kitchener, Ont.

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

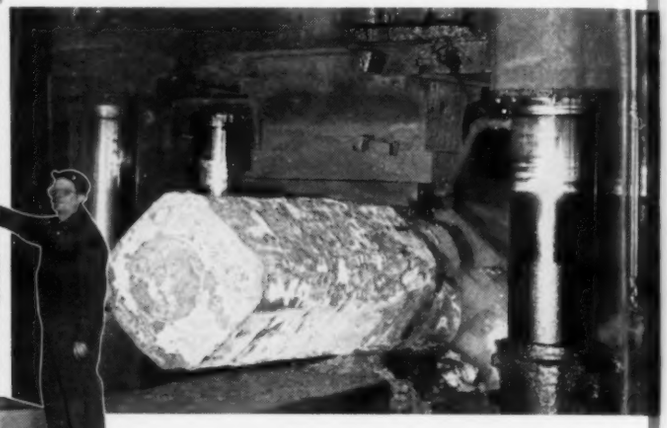


15-ft. planer in the Eddystone Division's Southwark Shop.

General Machine Shop at the Eddystone Division, Eddystone, Pa., whose 1,500,000 square feet of manufacturing space includes huge fabrication shops and a nonferrous castings foundry.

•

Blooming an ingot at the Standard Steel Works Division, Burnham, Pa., under one of the 2500-ton hydraulic presses.



Vast, integrated Baldwin-Lima-Hamilton facilities enable Loewy-Hydropress to deliver your rolling mills on time

When Loewy-Hydropress designs and builds your rolling mills, you aren't plagued by the usual troublesome and expensive delivery delay. For Loewy has at its disposal the vast, yet smoothly integrated resources of the entire Baldwin-Lima-Hamilton Corporation.

The two B-L-H divisions called upon most frequently to make parts for Loewy-designed rolling mills are the Standard Steel Works and Eddystone Divisions. The necessary steel components are cast or forged at Standard. And Eddystone, with its extensive machining facilities, supplies the completely finished nonferrous castings and weldments. Other members of the B-L-H family with excellent facilities for producing rolling mill parts are the Hamilton Division, Hamilton, Ohio; the Austin-Western Division, Aurora, Ill.; and the Madsen Division, La Mirada, Calif.

Close coordination among all Baldwin-Lima-Hamilton divisions is the chief reason why Loewy-Hydropress can deliver your rolling mills faster.

To your individual production requirements, we design, build and install hot and cold rolling mills for ferrous and nonferrous metals, continuous merchant and wire-rod mills, skelp mills, two-high and three-high blooming mills, high-speed foil mills, continuous billet and sheet-bar mills, strip, slabbing, plate, structural, rail mills, and special mills. Write us today, Dept. C-4, for illustrated bulletin L-164.

Loewy-Hydropress designers at the company's headquarters in New York City.

Loewy-Hydropress Division

BALDWIN · LIMA · HAMILTON

111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

BALDWIN BLH LIMA-HAMILTON

can be prevented by USG® BRUSHES . . .

with STATITE® permanent shunt connections

When a motor is out . . . you're money out. If you want to eliminate downtime caused by shunts jarring loose or being pulled out, we suggest you try USG Brushes with Statite. Statite is a permanent shunt connection needing no hammerclips. It can't be jarred out even under severe operating conditions, and will assure your electric motors of steady, maintenance-free performance. In addition, Statite shunt connections, which eliminate troublesome rivets, retain their original low millivolt shunt drop, cannot oxidize, and are unaffected by temperature extremes. USG Brushes are manufactured in a variety of types and sizes for all applications from fractional horsepower to diesel generator. Grades available include carbon and carbon-graphite, electrographitic, graphite, metal graphite, and silver graphite.

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 9, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® SINTERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

SEND THE ATTACHED COUPON . . .
for Engineering Handbook B-56 and
Brush Grade Supplement.

231

THE UNITED STATES GRAPHITE COMPANY
SAGINAW, MICHIGAN

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

_____

Applications for AISE Membership

Active

WALTER F. ACKERMANN
Utilities Analyst
U. S. Steel Corp.
Fairless Works
Fairless Hills, Pa.

W. GUY CALLAHAN
Junior Power & Fuel Engineer
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Provo, Utah

JAMES M. CATES
Turn Foreman Inspection Dept.
U. S. Steel Corp.
Consolidated Western Steel Div.
Provo, Utah

L. S. CHRISTENSEN
Storekeeper
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Provo, Utah

WALTER J. CLARK
Specification & Processing Metallurgist
Great Lakes Steel Corp.
Ecorse, Mich.

KENNETH M. CLARKE
Supt. Production Planning & Control
Algoma Steel Corp. Ltd.
Sault Ste Marie, Ontario, Canada

KENNETH COPELAND
Chief Electrician
U. S. Steel Corp.
American Steel & Wire Div.
Donora, Pa.

JAMES J. DALTON
General Supt.
U. S. Steel Corp.
American Steel & Wire Div.
Cleveland, Ohio

WILLIAM G. DAVEY
Asst. to Manager of Operations
Algoma Steel Corp., Ltd.
Sault Ste Marie, Ontario, Canada

STANLEY J. GILLEN
Asst. General Manager
Ford Motor Co.
Steel Division
Dearborn, Mich.

PHILIP J. GOW
Asst. to General Supt.
U. S. Steel Corp.
American Steel & Wire Div.
Donora, Pa.

HUBERT W. GREENE
Mechanical Draftsman
U. S. Steel Corp.
Tennessee Coal & Iron Div.
Fairfield, Ala.

S. G. GUILFORD
Asst. Chief Engineer
Republic Steel Corp.
Gadsden, Ala.

STANLEY GUTOWSKI
Supervisor, Order & Schedule Dept.
Great Lakes Steel Corp.
Ecorse, Detroit, Mich.

KARL A. HANSON
Inspection & Test Laboratory Supervisor
U. S. Steel Corp.
Consolidated Western Steel Div.
Provo, Utah

JAMES D. HILLEKE
Chief Steam Engineer
Republic Steel Corp.
Gadsden, Ala.

EMIL FRED KATZINSKI
General Foreman Field Maintenance
U. S. Steel Corp.
Clairton Works
Clairton, Pa.

THOMAS MITCHELL KILGO
Electrical Engineer
Armco Steel Corp.
Butler, Pa.

MACK C. KITCHEN
Turn Foreman Rod Mill
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Pittsburg, Calif.

JAMES W. LOWRY
Purchasing Agent
Republic Steel Corp.
Cleveland, Ohio

ROBERT M. LUTHER
Maintenance Foreman
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

JOHN T. McGERVEY
Industrial Engineer
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Pittsburg, Calif.

JOHN MACNAMARA
Asst. to Supt.
Algoma Steel Corp.
Sault Ste Marie, Ontario, Canada

ABE MAYBERRY
Supt. Hot & Cold Strip Mills
Algoma Steel Corp., Ltd.
Sault Ste Marie, Ontario, Canada

PETER MILLER
Senior Engineer
Acme Steel Co.
Chicago, Ill.

WALLACE A. NABORS
Asst. Supt. Blast Furnaces
Republic Steel Corp.
Gadsden, Ala.

JOHN P. PEACOCK, JR.
Chief Engineer
Bethlehem Steel Co.
Sparrows Point Plant
Sparrows Point, Md.

SAMUEL B. PRELLWITZ
Development Metallurgist
U. S. Steel Corp.
Fairless Hills, Pa.

C. CHESTER PULLEN
Asst. General Foreman
Saucon Maintenance Dept.
Bethlehem Steel Co.
Bethlehem, Pa.

JOHN M. ROBBINS
Laboratory Foreman
U. S. Steel Corp.
Consolidated Western Steel Div.
Provo, Utah

HENRY L. ROONEY
Finishing End Foreman—10 in. & 14 in. Mills
Inland Steel Co.
East Chicago, Ind.

LOUIS SANDOR
Engineer
Inland Steel Co.
East Chicago, Ind.

WILLIAM HUGH SCHOFIELD
Executive Mechanical Engineer
Richard Thomas & Baldwins, Ltd.
Bridgend, Galamorgan, Great Britain

GEORGE W. SMITH
Lubrication Engineer
U. S. Steel Corp.
American Steel & Wire Div.
Cleveland, Ohio

VERL R. SMITH
Chief Draftsman
Bethlehem Pacific Coast Steel Corp.
Los Angeles, Calif.

ROBERT H. STORY
Inspector
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Geneva, Utah

VON B. STOUGHTON
Asst. Electrical Foreman
Bethlehem Steel Corp.
Lackawanna, N. Y.

JOHN C. SWENSON
Inspection Turn Foreman
U. S. Steel Corp.
Consolidated Western Steel Div.
Provo, Utah

B. L. YATES
Asst. Chief Steam Engineer
Republic Steel Corp.
Gadsden, Ala.

HOWARD D. YOUMANS
Asst. Chairman Rolling Committee
U. S. Steel Corp.
American Steel & Wire Div.
Cleveland, Ohio

DONALD E. YOUNG
Supt. Utilities
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Provo, Utah

JOHN A. WALSH
Asst. Supt.
Algoma Steel Corp.
Sault Ste Marie, Ontario, Canada

Associate

WALTER BEACHY, JR.
Design Engineer
Blaw-Knox Corp.
Foundry & Mill Machinery Div.
Pittsburgh, Pa.

HENRY CEBERS
Senior Electrical Design Engineer
Kaiser Engineers
Oakland, Calif.

WILLMER C. CIMPRICH
Sales Agent
Midwest Lighting Products Co.
Cleveland, Ohio

WILLIAM J. DAVIES
District Manager
Worthington Corp.
Cleveland, Ohio

ROBERT A. EIDAM
Sales Engineer
Blaw-Knox Corp.
Foundry & Mill Machinery Div.
East Chicago, Ind.

GALE V. FAUVER
Supt.
Tri-City Electric Co.
Hammond, Ind.

PAUL C. FORD
Executive Engineer
Wagner Electric Corp.
St. Louis, Mo.

BRUCE A. FOUNTAIN
Sales Representative-Electrode Products
National Carbon Co.
Pittsburgh, Pa.

EUGENE F. GARDNER
Sales Representative
Midvale-Heppenstall Co.
Pittsburgh, Pa.

NORMAN R. GINDRAT
Asst. Chief Design Engineer
Kaiser Engineers
Oakland, Calif.

ERNEST E. HAJEK
Project Engineer
Kaiser Engineers
Oakland, Calif.

ROBERT H. HAUICE
Application Engineer
The Wean Engineering Co., Inc.
Warren, Ohio

ROBERT J. HARRIS
Application Engineer
The Wean Engineering Co., Inc.
Warren, Ohio

DONALD WILLIAM HOWARD
Sales Engineer
English Electric Co. of Canada, Ltd.
St. Catharines, Ontario, Canada

GEORGE M. HUNTER
Application Engineer
The Wean Engineering Co., Inc.
Warren, Ohio

KARL G. ILLERT
Proposal Engineer
United Engineering & Foundry Co.
Pittsburgh, Pa.

DONALD E. INGALLS
Partner
C. E. Ingalls & Sons
San Francisco, Calif.

M. EDWARD LESKO
Sales Engineer
Steel Sash Service, Inc.
Chicago, Ill.

WILLIAM M. McMILLEN
Application Engineer
The Wean Engineering Co., Inc.
Warren, Ohio

JAMES A. MICHEL
Sales Engineer
National Carbon Co.
New York, N. Y.

PAUL W. MILLER
Application Engineer
The Wean Engineering Co., Inc.
Warren, Ohio

GEORGE ANSLEY MITCHELL
Sales Dept.
Lombard Corp.
Youngstown, Ohio

WILLARD H. NEU
District Manager
Leeds & Northrup Co.
Philadelphia, Pa.

DYKE B. ORMS
Jr. Application Engineer
The Wean Engineering Co., Inc.
Warren, Ohio

HAROLD KENNETH REYNOLDS
Asst. Project Engineer
Mannesmann-Meer Engineering Construction Co.
Easton, Pa.

RICHARD W. RUSTAD
Sales Engineer
Titzel Engineering & Equipment Co.
Pittsburgh, Pa.

JOHN R. SHALLCROSS
Sales Engineer
Westinghouse Electric Corp.
Philadelphia, Pa.

H. J. SHANER
Chicago District Sales Manager
The Ramtite Co.
Division of The S. Obermayer Co.
Chicago, Ill.

CHARLES K. SMITH
President
Smith of Philadelphia
Philadelphia, Pa.

CLARE K. TUBBS
Sales Engineer
Allis-Chalmers Manufacturing Co.
Detroit, Mich.

JOHN W. VOELZKE
Staff Engineer
Patterson-Emerson-Comstock, Inc.
Pittsburgh, Pa.

MELVIN G. WILLIAMSON
Sales Representative
Allis-Chalmers Manufacturing Co.
San Francisco, Calif.

Junior

JOHN BOYNE SUTTON
"B" Engineer
Electrical Dept.
Bethlehem Steel Co.
Lakawanna Plant
Buffalo, N. Y.

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SAL
POSITIONS VACAN
POSITIONS WANTE

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

BIRMINGHAM DISTRICT

DIXIE ENGINEERING COMPANY
"Manufacturer's Agents"
812-813 Protective Life Building
BIRMINGHAM 3, ALABAMA
Sobel E. Baum — Telephone 4-0417

CHICAGO DISTRICT

PAUL W. WENDT & SONS
Manhattan Building
CHICAGO 5, ILLINOIS
District Representatives for
A. W. CADMAN MFG. CO.
HUNTER SAW & MACHINE CO.
GRAFO COLLOIDS CORP.

EHRET AND KINSEY
Board of Trade Bldg., 141 West Jackson Blvd.
Chicago 4, Illinois — Wabash 2-0449
Representing
THE CLEVELAND WORM AND GEAR CO.
"Cleveland" Worm Gearing and Worm Gear Speed Reducers—30 Years
THE FARVAL CORPORATION
"Farval" Centralized Lube Systems—30 Years
LUBRICATION PRODUCTS COMPANY
"Strapax" Journal Box Lubricator—24 Years
AMERIGEAR-ZURN, INC.
"Amerigear" Flexible Couplings—9 Years
WALDES KOHINOOR, INCORPORATED
"Truarc" Retaining Rings—11 Years
2400 W. Clybourn St. — Phone:
Milwaukee 3, Wisc. — Division 2-7844

PITTSBURGH DISTRICT

ROLLING MILLS and EQUIPMENT
FRANK B. FOSTER, INC.
2220 OLIVER BUILDING PITTSBURGH 22, PA
Cable Address "FOSTER" Pittsburgh

AUBURN AND ASSOCIATES, INC.
ENGINEERS
COMPLETE
ENGINEERING . DESIGN . LAYOUT
FOR
STEEL MILLS AND HEAVY INDUSTRY
923 Penn Ave., Pgh. 22, Pa.
Telephone COurt 1-5014

PITTSBURGH (Continued)

W. G. KERR CO., INC.
1005 Liberty Ave. — PITTSBURGH, PA.
Phone: ATlantic 1-4254
Representing:
FOOTE BROS.—Gears and Speed Reducers
REEVES—Variable Speed Drives
THOMAS—Flexible Couplings
WICHITA—Air Tube Disc Clutches & Brakes
TELSMITH—Telsmith Crushers
CULLEN-FRIESTEDT—Sheet Lifters—Welding Positioners—Track Cranes

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
184 Sandy Creek Road — (Penn Township)
P. O. Box 10597 — PITTSBURGH 35, Pa.
CHurchill 2-1750

RITTER ENGINEERING CO.
Engineers • Distributors • Contractors
1515 W. LIBERTY AVE. — Phone:
PITTSBURGH 26, PA. — LOCUST 1-1303
TRABON—Centralized Lubricating Systems
METERFLO—Circulating Oil Systems
PARKER—Hydraulic & Fluid System Components
"Specialists in Lubrication and Hydraulics"

ELECTRICAL INSTALLATIONS
PATTERSON EMERSON COMSTOCK, INC.
PITTSBURGH, PA.
STEEL MILLS—INDUSTRIALS
UTILITIES
313 EAST CARSON ST. — ZONE 19

CONSULTING ENGINEERS

ROSS E. BEYNON
Consultant
ROLLING LAYOUT AND ROLL DESIGN
7658 Coles Avenue — Chicago 49, Illinois
Telephone SAginaw 1-3466

W. VANCE MIDDOUGH & ASSOCIATES
Consulting Electric Engineers
Engineering • Design • Layout
Heavy Industrial Power & Light
Frederick Building — Cleveland 15, Ohio
Prospect 1-2060

Consulting Engineers (Continued)

HOUSER AND CARAFAS ENGINEERING CO.
Engineering for Industry
4 Smithfield Street — Pittsburgh 22, Pa.
Phone: GRant 1-9929

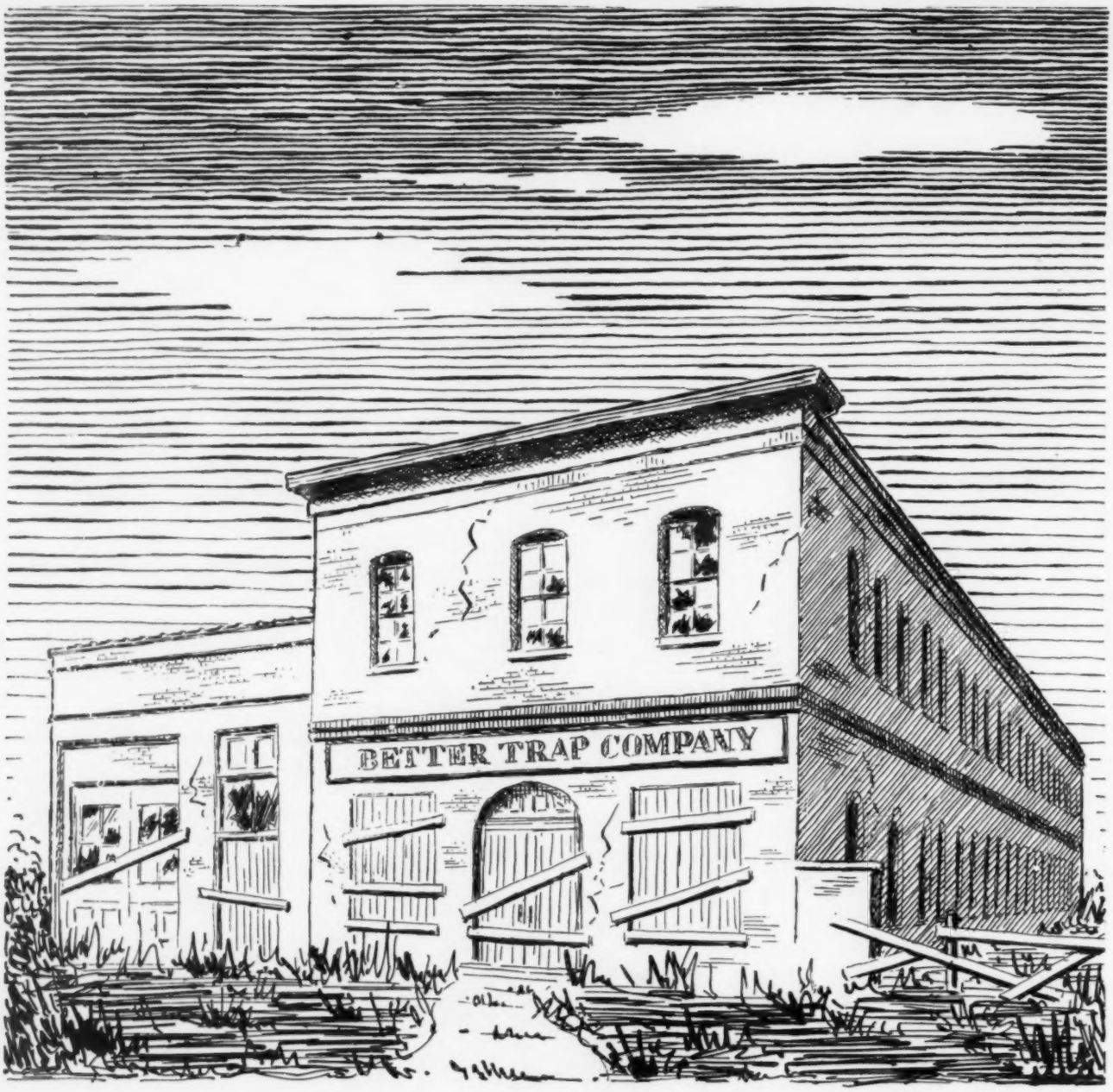
MARTIN J. CONWAY
Consulting Fuel Engineer
111 South Duke Street — Millersville, Pa.
Tel. 6153
Steel Industry Representative for
CHEMICAL CONSTRUCTION CORPORATION
P-A- VENTURI SCRUBBER
Cleaning Blast Furnace, Converter, Open Hearth and Scarfing Gases. Bulletins Available.

National Design & Detailing Co.
3633 Brownsville Road
Pittsburgh 27, Pa.
TUxedo 4-2200 — **Cable: DETAILCO**
Structural-Mechanical-Electrical
COMPLETE INDUSTRIAL PLANTS
Sintering Plants • Foundries • Mill Bldgs.
Welding Consultants

ENGINEERING SERVICE BUREAU
Structural • Mechanical • Electrical
Plans • Design • Layout
BEN MACCABEE — 173 W. Madison St. CHICAGO 2, ILL.

Specialist in Electrical
● DESIGN
● LAYOUT
● INSTALLATIONS
VALENTZ ENGINEERING CO.
Engineers & Consultants
611 W. Market — **Warren, Ohio**

PRODUCTS



MOUSETRAP, STEAM TRAP, SEWER TRAP

...it makes no difference

. . . the world *won't* beat a path to the door of the man who builds a better one *and then doesn't advertise it* so that people will know about his product, know where it can be bought and how much it costs.

Advertising benefits the buyer, too. It tells you the product story, makes it easy for you to buy. Even more important to you, advertising leads to mass production and volume sales . . . which means lower costs and lower prices.

Yes, "Advertising Benefits You" . . . 'specially business-paper advertising.

IRON AND STEEL ENGINEER

INDEX TO ADVERTISERS

APRIL, 1957

A

Aetna-Standard Engineering Co. 1
Air Reduction Sales Co. 182
Allen-Bradley Co. 204
Alliance Machine Co. 22, 23
Allis-Chalmers Manufacturing Co. 32, 68, 69, 154, 155
Allis Co., Louis 193
Alloy Metal Products, Inc. 186
American Air Filter Co. D-37
American Brakeblok Division, American Brake Shoe Co. 217
American Bridge Division, United States Steel Corp. 189
American Shear Knife Co. 220
Ampco Metal, Inc. 222
Askania Regulator Co. 215
Atlas Car and Manufacturing Co. D-51

B

Babcock and Wilcox Co., The 211
Baker Co., The J. E. D-32
Bailey Meter Co. 16
Bearings, Inc. 160
Bedford Foundry and Machine Co. D-40
Berry Bearing Co. 44
Birdsboro Steel Foundry and Machine Co. 20
Blaw-Knox Co., Foundry and Mill Machinery Division 171, 172
Bliss Co., E. W. 49
Bloom Engineering Co., Inc. 230
Bristol Co., The 184, 185
Brooks Oil Co., The 179
Browning and Co., Victor R. 198
Buffalo Forge Co. 235
Bussmann Manufacturing Co. 150, 151

C

Chemical Construction Corp. 232
Chicago Concrete Breaking Co. 203
Clark Controller Co. 5
Cleveland Crane and Engineering Co. 10
Cleveland Worm and Gear Co., The D-54, Cover 3
Columbus McKinnon Chain Corp. 226
Cone Drive Gears Division, Michigan Tool Co. 194
Cowles Tool Co. 223
Cunningham Co., M. E. 197
Cutler-Hammer, Inc. Cover 2

D

DeLaval Steam Turbine Co. 228
Delta-Star Electric Division, H. K. Porter Co., Inc. 174
Detrick Co., M. H. D-47
Diamond Power Specialty Corp. 173
Documentation and Licenses, Paris, France D-35
Dowell, Inc. 156
Dravo Corp. 60, 197
Drever Co. 34
Duraloy Co., The 214

E

Eichleay Corp. D-30
Electric Controller & Mfg. Co., The, Division of the Square D Co. D-22, D-23, D-31
Electric Furnace Co., The 56
Electric Service Works, Delta-Star Electric Division, H. K. Porter Co., Inc. 175
Electro Alloys Division, American Brake Shoe Co. 26
Euclid Electric and Mfg. Co. 202
Exide Industrial Division, Electric Storage Battery Co. 200, 201

F

Farval Corp., The D-53
Feller Engineering Co. 161
Flinn and Dreffein Engineering Co. D-35
Foxboro Co., The 224
Frantz Co., Inc., S. G. 197

G

Garlock Packing Co., The 231
Gear Grinding Machine Co. 233
General Refractories Co. 225
General Steel Castings Corp., National Roll & Foundry Division 14
Golden-Anderson Valve Specialty Co. 220
Great Lakes Carbon Corp. 159
Gulf Oil Corp. 58, 59
Guyan Machinery Co. 229

H

Hagan Chemicals and Controls, Inc. 52, 53
Hallden Machine Co., The D-35
Harbison-Walker Refractories Co. 55
Harnischfeger Corp. 66
Herr Equipment Corp., The 168
Heyl and Patterson, Inc. 19
Holophane Co. 221
Hyatt Bearings Division, General Motors Corp. D-49
Hyde Park Foundry and Machine Co. 226

I

Ingersoll-Rand Co. D-27
Iron Lung Ventilator Co. D-46
Ironsides Co., The 70, 71
I-T-E Circuit Breaker Co. 12

J

Joy Manufacturing Co. 6

K

Kaiser Aluminum and Chemical Corp., Inc. 178
Koppers Co., Inc. 8, 9, D-36

L

Larco, Inc. 232
Lectromelt Furnace Co. 74
Link-Belt Co. 29, 183
Loewy-Hydropress Division, Baldwin-Lima-Hamilton Corp. 236
Loftus Engineering Corp. D-26

M

Mackintosh-Hemphill Division, E. W. Bliss Co. 149
Manning, Maxwell and Moore, Inc. 210
Mansaver Industries, Inc. 202
Markal Co. 13
McGregor-Michigan Corp. 227
McKiernan-Terry Corp. 50
Mesta Machine Co. Cover 1
Miles and Partner, John, London, Ltd. D-35
Minneapolis-Honeywell Regulator Co. 218, 219
Morgan Construction Co. 25
Morgan Engineering Co., The 180, 181
Morgardshammars 152

N

National Carbon Co., Division Union Carbide and Carbon Corp. 2, 35, 36, 37, 38, 39, 40, 41, 42
National Electric Coil Co. 196
National Roll & Foundry Division, General Steel Castings Corp. 14

O

Ohio Electric Manufacturing Co., The 15
Ohio Steel Foundry Co., The 166
Okonite Co., The 64

P

Pangborn Corp. 61
Parker Appliance Co., The 199
Patterson-Emerson-Comstock, Inc. D-48
Pennsylvania Transformer Co. 72
Pittsburgh Engineering and Machine Co. D-24, D-25
Poole Foundry and Machine Co. 242
Post-Glover Electric Co. D-29

R

Radio Corp. of America 67
Ramtite Co., The 169
Refractory and Insulation Corp. 216
Reliance Electric and Engineering Co. 21
Rockbestos Products Corp. 54
Rollway Bearing Co., Inc. 73
Rust Furnace Co. D-21
Rust-Oleum Corp. 7

S

Salem-Brosius, Inc. 51
Simmons Machine Tool Corp. 225
Spraying Systems Co. D-41
Square D Co., The Electric Controller & Mfg. Co. D-22, D-23, D-31
Stamco, Inc. D-45
Stearns Electric Corp. 24
Sun Oil Co. 4
Surface Combustion Corp. 62, 63
Sutton Engineering Co. 163
Syntron Co. 170

T

Tapecoat Co., The 229
Taylor Chain Co., S. G. 177
Taylor Sons Co., Charles, The D-44
Texas Co., The Cover 4
Thermal Transfer Corp. D-34
Timken Roller Bearing Co., The D-28
Tool Steel Gear and Pinion Co. D-42, D-43
Torrington Co., The 153
Trabon Engineering Corp. 212
Treadwell Engineering Co. 31

U

Union Carbide and Carbon Corp., National Carbon Co. 2, 35, 36, 37, 38, 39, 40, 41, 42
United Engineering and Foundry Co. 17
United States Graphite Co. 237
United States Steel Corp., Industrial Cars 57

V

Vaughn Machinery Co., The D-33

W

Wagner Electric Corp. 18
Wean Engineering Co., Inc., The D-35
Wean Engineering Co., of Canada, Ltd., The D-35
Wean Equipment Corp. D-35
Western Gear Corp. 190
Western Precipitation Corp. 43
Westinghouse Electric Corp. 45, 46, 47, 48, 164, 165, 208, 209
Wheelabrator Corp. 162
Wilputte Coke Oven Division, Allied Chemical & Dye Corp. D-38, D-39
Wilson Engineering Co., Inc., Lee D-50

Y

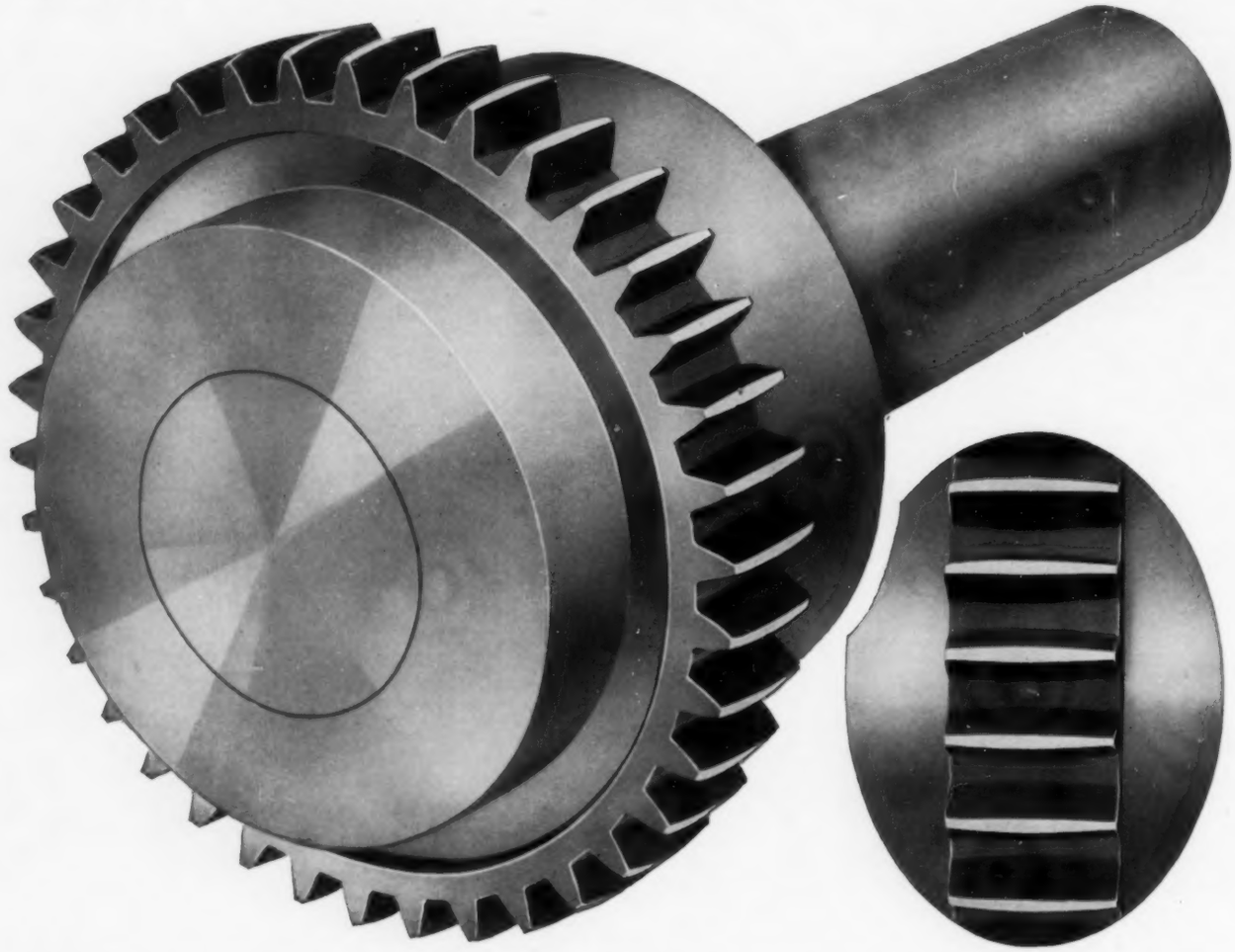
Yoder Co., The 176
Youngstown Alloy Casting Corp. 65
Youngstown Welding and Engineering Co. D-52

POOLE

CURVED TOOTH COUPLINGS FOR GREATER MISALIGNMENT

We are now equipped to furnish on special order, couplings up to and including size No. 12 with curve-sided hub teeth, permitting misalignment up to plus or minus 5°.

This feature solves many problems where excessive misalignment becomes unavoidable, such as coupling arrangements which necessitate changing centers of rolls etc., or any sort of drive requiring more than the standard plus or minus 1°.



The method by which this is done represents the very latest gear cutting process. Gear teeth cut by this amazing and ultra modern method are not only to a precise and absolutely true shape, but are also generated to tolerances of astounding accuracy.

Engineers and draftsmen, when confronted with coupling problems involving more than the usual amount of misalignment, are invited to submit such problems to us for recommendation to suit their exact requirements.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY 1700 UNION AVE. BALTIMORE 11, MD.

Millroom in Atlantic Steel's new plant. In the right foreground you see the Cleveland unit which serves as Kick-off Drive on the Shear Discharge Table.

8 CLEVELAND drives equip new DIXISTEEL TRADE MARK bar mill

ONE of the finest, fastest, most versatile of the recent additions to America's steel processing facilities is a new 13" merchant bar and rod mill at Atlanta, Georgia. In operation since last November, this mill produces rods, rounds, flats, angles, channels and light sections of various sizes under the well-known name of Dixisteel, trademark of the Atlantic Steel Company.

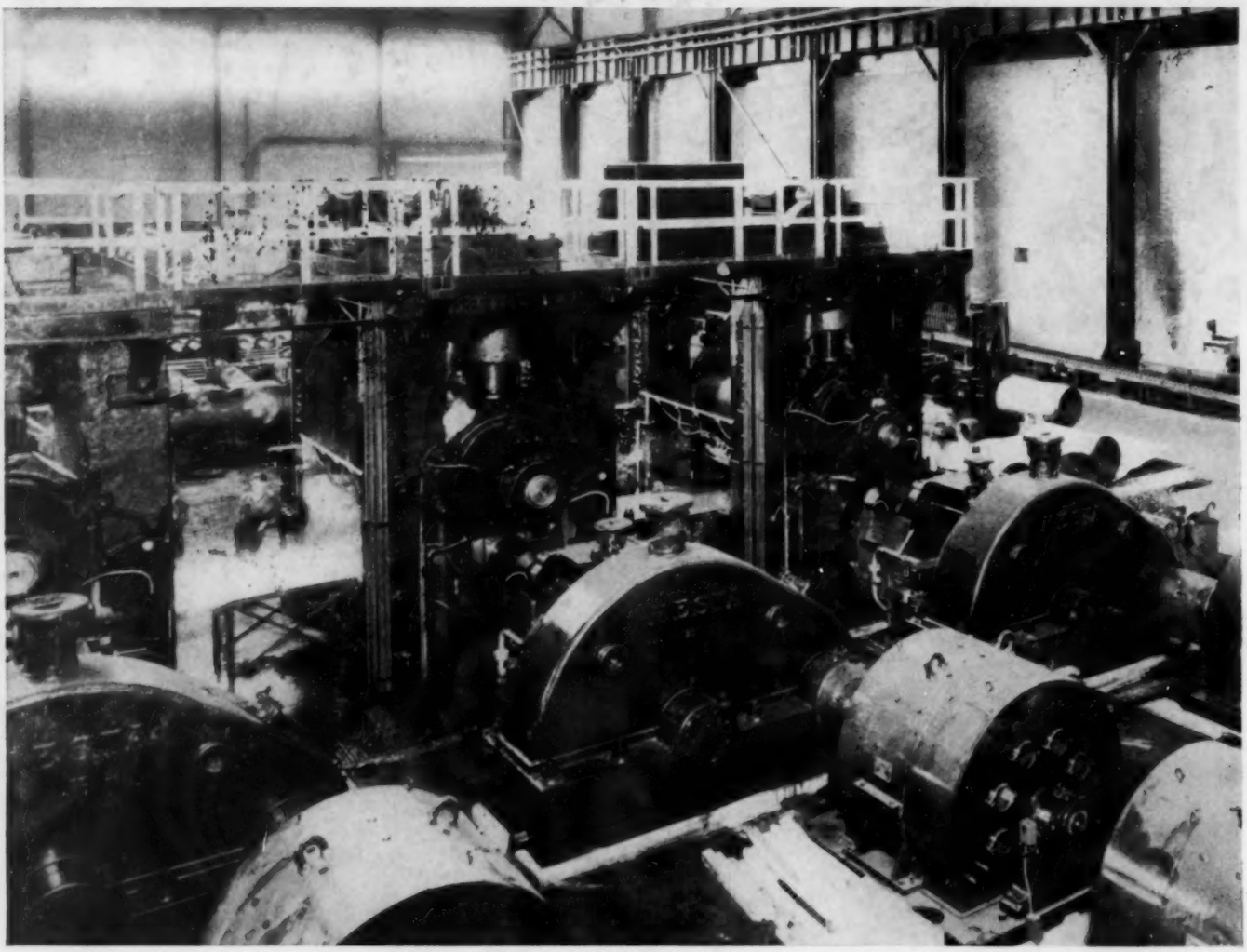
Power transmission equipment includes another famous name product—Cleveland Worm Gear Speed Reducers —of which 8 heavy-duty units are employed as drives on the mill discharge table and cooling bed carry-over.

Whenever drives must handle heavy loads under difficult conditions—efficiently, economically, continuously, dependably—industry chooses Clevelands. There are models to meet every requirement, wherever a powerful right-angle drive is preferred. To see the complete line, write for a copy of Bulletin 145—just off press.

The Cleveland Worm and Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers, Limited.

CLEVELAND
Worm Gear
Speed Reducers



PROTECT REDUCTION GEARS

against Heaviest Loads

It's the polar additives in *Texaco Meropa Lubricant* that *keep* it clinging to gear teeth and bearing surfaces even when gears are working under severe conditions of heat, pressure, or moisture.

What's more, the extreme pressure properties of *Texaco Meropa* give it a tougher, longer lasting lubricating film that effectively protects against shock or heavy steady loads. And it resists oxidation and thickening—won't foam or separate. All good reasons why gears run smoother, last longer, and maintenance costs stay low.

There is a complete line of Texaco Lubricants designed to help you get the most efficient performance from your equipment. A Texaco Lubrication Engineer will be glad to suggest those best suited to your needs. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Meropa Lubricants

FOR STEEL MILL GEAR DRIVES

TUNE IN . . . METROPOLITAN OPERA RADIO BROADCASTS EVERY SATURDAY AFTERNOON